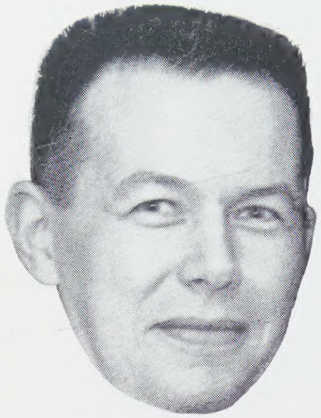
Tappi

THE JOURNAL OF THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

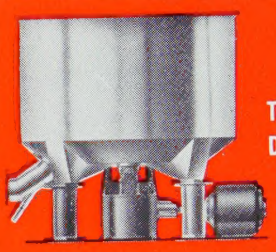
NOVEMBER 1961

VOLUME 44 • NUMBER 11



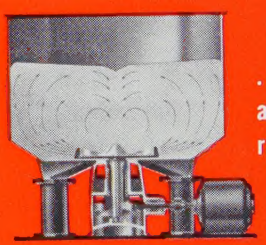
"The Emerson Dualator does the best defibering job of any equipment we know about"

says **David W. Peat**, Manager of Manufacturing of the Gilman Paper Company, Gilman, Vermont.



The Emerson Dualator

. . . employs contra-rotating rotors which form a cylindrical zone of positive defibering action



. . . and develops a distinctive radial stock flow.

NEW EMERSON DUALATOR REDUCES DEFIBERING TIME AND ENERGY INPUT AT GILMAN

"Following our search for a pulper that could defiber hard-sized and wet strength broke effectively with minimum use of heat and chemicals," continued Mr. Peat, "we chose the Emerson Dualator. A full year of continuous operation proves it does the job better and faster than previous methods with far less power per ton of throughput."

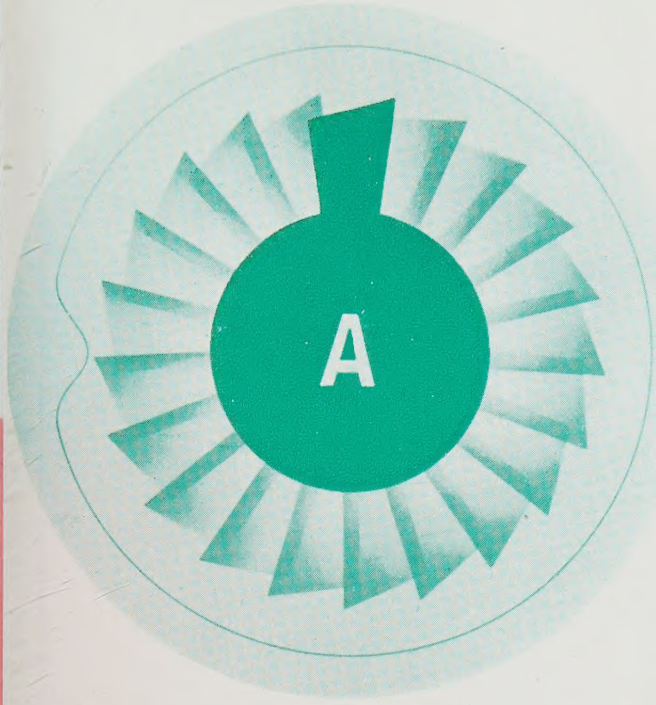
Small wonder at Gilman's enthusiasm! Based upon an entirely new defibering concept, the Dualator is the most advanced pulper ever developed.

Utilizing two bottom rotors operating in opposite directions on the same axis, a cylindrically shaped defibering zone is defined by the narrow clearance between the inner and outer rotor vanes. Stock is directed from the inner rotor into the path of the outer rotor vanes. This abrupt reversal in direction, at an interfacial speed of 6,000 fpm, produces tremendous hydraulic shear forces that literally rip the stock to shreds, with no sacrifice in fiber length.

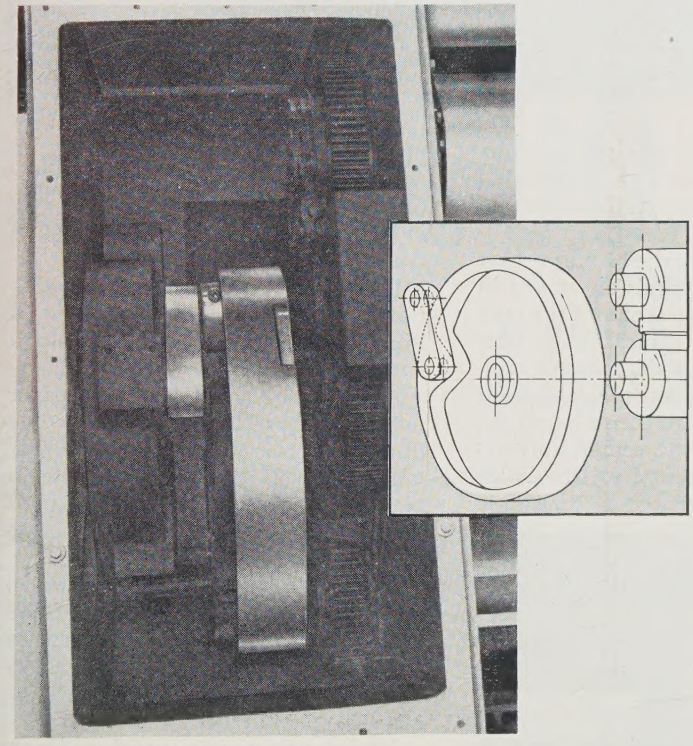
The revolutionary design of the new Emerson Dualator reduces the defibering time and energy input of conventional pulpers by at least one half. With contra-rotating rotors, energy is converted to productive pulping. None is wasted in needless circulation. This means more tons/day of complete, efficient defibering. It permits the use of smaller tubs and, in many instances, reduces or eliminates the necessity of using chemicals and/or heat. A distinctive radial flow pattern develops from the interaction of the two rotors, which permits operation at as little as 25% of tub capacity with no splashing.

Your mill can benefit from owning an Emerson Dualator as has the Gilman Paper Company. For complete information, write The Emerson Manufacturing Co., Division of John W. Bolton & Sons, Inc., Lawrence, Massachusetts.

BOLTON EMERSON
TRADE MARK



IMAGINATION UNLIMITED RESOLVES PRECISION CUT-OFF



MODEL—JL AUTOMATIC SHEET CUT-OFF

. . . this kind of visionary inventiveness plus imaginal machine designing — applied to each engineering challenge — envisioned and created S & S Precision Cut-Off!

PROBLEM: To obtain greater sheet length accuracy and eliminate excessive wear on cut-off mechanism.

SOLUTION: A unique Counter-Balanced System — comprising a *Counter-Balance Wheel and Driving Link 180° out-of-phase with knife bar crank — counteracts dynamic forces in variable cyclic movements. This design effects (A) deceleration of Counter-Balance Wheel while Knife Bars accelerate. During remainder of cycle (B), Counter-Balance accelerates and Knife Bars decelerate.

RESULTS: Diminished cyclic load on drive to knife bars assures **precision** sheet length control — decreased wear on machinery parts — uniform power consumption.

. . . New, modern S & S imagineering and continuous traditional machine research developed this advanced achievement on Model-JL for shearing profitably and maintaining foremost machine reliability.

*Patent Pending

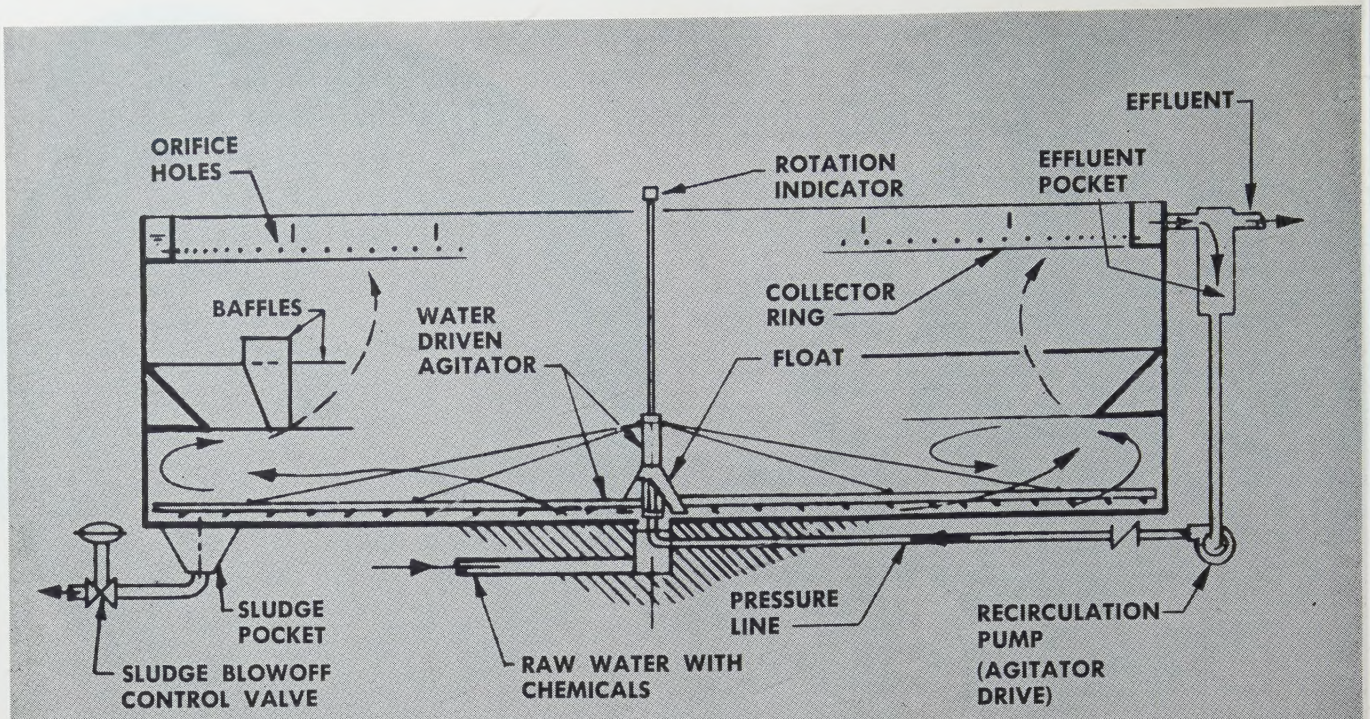
S&S CORRUGATED PAPER MACHINERY CO., INC.

160 NORTH 4th ST., BROOKLYN 11, N. Y. • STAGG 2-9700

S&S machines are produced in the United States, Holland, Italy and England

WHEN YOU WANT THE BEST . . . SPECIFY S & S

REC'D NOV 17 1961



Will this new precipitator change your thinking about costs, shock loads?

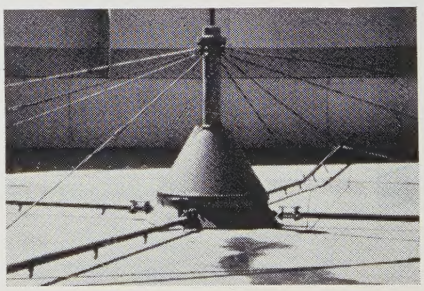
New Permutit Type M Precipitator ... a study in simplicity

Now in operation is this new precipitator for reducing turbidity and color in water.

We call it the Permutit Type M Precipitator. It is a study in simplicity, and because of its low construction and operating costs, it opens up new opportunities to obtain solids-contact clarification at minimum cost.

"Missing" parts: There is no motor-driven agitator on the Permutit Type M Precipitator. No extensive baffling. No center platform. No access walkway. All these have been done away with, because the unit has a new and different agitator system which sweeps away the settled sludge. Rotating agitator arms are supported by a "semi-buoyant" hub (or float) which revolves about a bearing post on the tank floor. Recycled effluent drives the agitator through jet nozzles located at the end of each arm. Smaller jets, spaced along the arms, gently nudge the settled sludge toward a sump at the outer rim of the tank floor.

Briefly, this is how the M unit works: raw water and chemicals are mixed in line and enter at the center of the tank floor beneath the conical rotor float which deflects the fluid mixture radially outward to the walls. A horizontal baffle on the tank wall then reverses the flow back toward the center thus imparting a rolling action to the sludge blanket. This current flow constantly places previously formed sludge in intimate mixture with the raw water immediately as it enters the tank. Clarified, effluent is collected by a flume at the top.



Agitator float and hub assembly.

Sudden water changes: An additional benefit of the Permutit Type M Precipitator is its exceptional ability to handle shock loads.

A case in point: red dye from a paper mill a mile upstream showed up one day in the raw water entering a Permutit Type M Precipitator in use in New England. But the unit went right on putting out an effluent with no significant change in quality.

So much interest has been shown in this new unit that we have reprinted the paper, "A Recent Development in Solids Contact Clarification Design", by E. D. Driscoll of Permutit. We'll be glad to send you a copy.

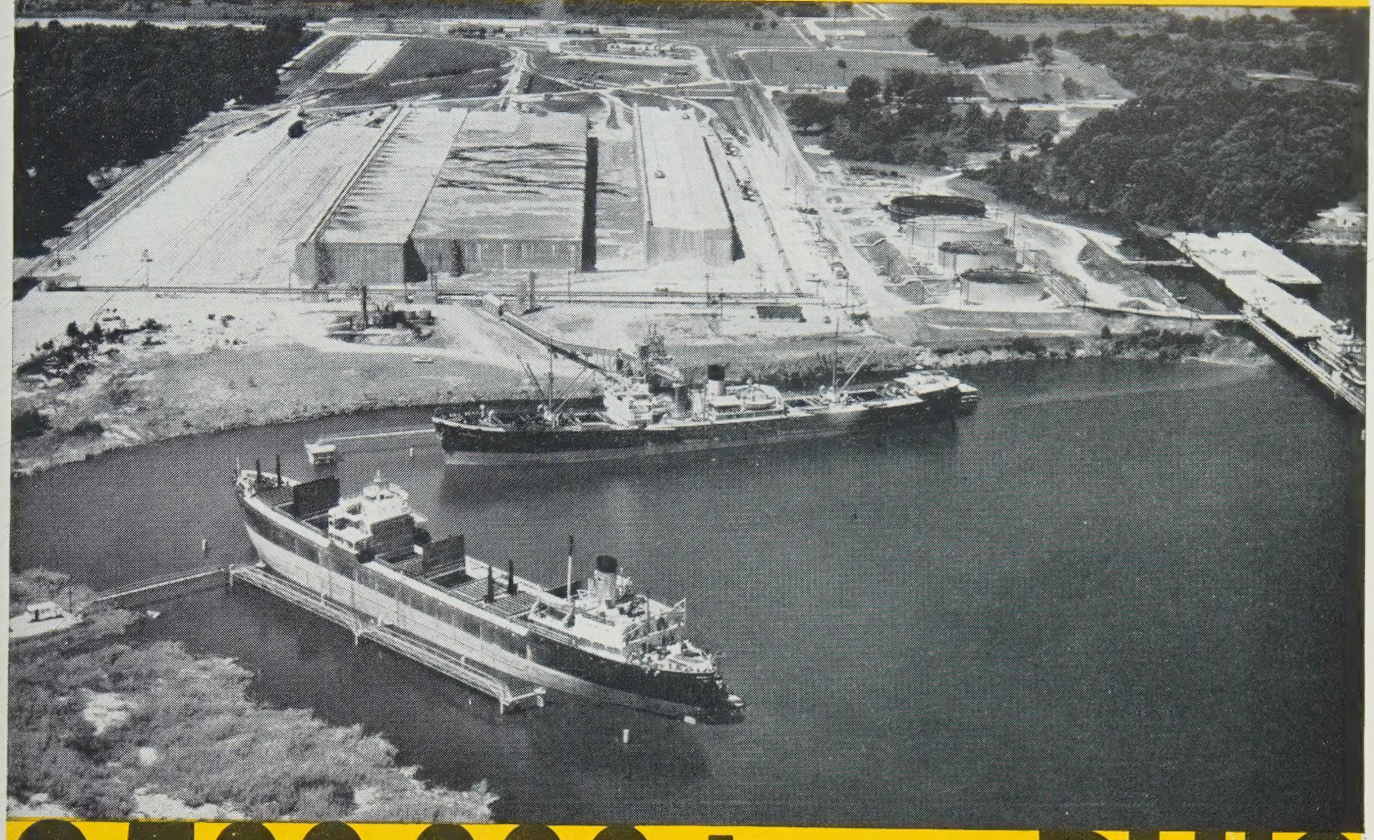
Write to Permutit Division, Dept. TA-111, 50 West 44th St., New York 36, New York. (In Canada, contact the Permutit Company of Canada, Toronto.)

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

SULPHUR

View of our new large main storage and shipping terminal at Beaumont, Texas. Solid sulphur vats (top center)—part of our large inventory—with molten sulphur storage tanks to their right. Freighter (center) taking on solid sulphur; tank barges (right) loading molten sulphur. Empty freighter (lower center) at holding dock.



2,500,000 tons-PLUS

...a healthy reassuring TGS inventory!

At the close of 1960 stocks of Frasch-mined Sulphur in the United States...and it is this Sulphur that accounts for most of the world's inventory...totaled about 3,650,000 long tons.

What is the TGS contribution to this inventory? Better than two thirds. Combining inventories at its four Frasch producing properties in Texas with stocks at its main and regional terminals, TGS has a running inventory of about 2,500,000 tons or about 70% of U. S. total inventory. In addition, there is a considerable inventory at its gas recovery plant in Okotoks, Alberta.

2,500,000 long tons **plus** of TGS Sulphur...indeed, a healthy reassuring inventory!

TEXAS GULF SULPHUR COMPANY
75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas
Sulphur Producing Units: Newgulf, Texas • Moss Bluff, Texas
Fannett, Texas • Spindletop, Texas
Worland, Wyoming • Okotoks, Alberta, Canada

Tappi

NOVEMBER CONTENTS — *continued*

PRESIDENT

H. M. Annis
Oxford Paper Co.
230 Park Ave., New York 17, N. Y.

VICE-PRESIDENT

J. C. Wollwage
Kimberly-Clark Corp.
Neenah, Wis.

EXECUTIVE SECRETARY

P. E. Nethercut
Technical Association of the Pulp and Paper Industry
360 Lexington Ave.
New York 17, N. Y.

TREASURER

R. G. Macdonald

PUBLICATIONS COMMITTEE

J. C. Wollwage
W. C. Bloomquist
G. C. Kimble
W. P. Lawrence
H. A. Spencer

EDITORIAL BOARD

C. B. Christiansen
J. V. Cundelan
R. A. Dando
C. P. Donofrio
R. E. Durst
John Frankevicz
J. W. Gilbert
R. S. von Hazmburg
M. S. Kantrowitz
E. G. Locke
G. G. Maltenfort
E. F. Manogue
R. C. Masterman
M. N. May
R. H. Mosher
W. W. Roehr
J. R. Sanborn
J. E. Sapp
F. R. Sheldon
H. A. Spencer
H. W. Stevens
J. F. Theriault
J. Weiner

ASSOCIATION SECTION

12A **Opportunities Unlimited**
A. G. Sharp

22A **Development of Useful Products from Kraft Lignin**
Paul R. Wiley

95A **Association News and Events**

96A Twelfth Testing Conference report

107A Eleventh Corrugated Containers Conference report

108A Third TAPPI—ASQC EVOP Course report

109A Fourth International Mechanical Pulping Conference report

116A **TAPPI Notes**
Reference Materials for Testing

117A **TAPPI Profile**
G. W. E. Nicholson

119A **Personal Mention**

Industry Notes

122A Paper Manufacturers and Converters

138A Educational Institutions

139A Industry Suppliers

148A General

Divisions and Committees

149A Authorized Committee Projects
Converting and Consuming Division

Divisions and Committees, *(Continued)*

149A Plastic Laminates Committee

Engineering Division

150A Fluid Mechanics Committee

Research and Development Division

151A Microbiological Committee

Testing Division

152A Paperboard Testing Committee

154A **Employment Service**

Local Section Activities

156A Meeting Calendar

157A 1960–61 Activities of the Italian Section

159A **United States Patents on Papermaking—Second Quarter 1961**
Compiled by The Institute of Paper Chemistry

Papers of Current Interest

173A Precast Clay Coating
Frank D. Bergstein

175A The Examination of Boxboard Samples for Trace Quantities of Heavy Metals
Walter F. Weiss and Edward C. Stivers

176A Defining and Solving Toxicological Problems Related to the Pulp and Paper Industry by Use of Radioisotopes Techniques
Frank J. Dominiques and D. H. Andersen

178A Newsprint Quality Control
Vincent N. DeFelice

181A Development and Application of the Kopparfors Lining
Ray A. Menges, Ame Ahlstrom, and S. Olsson

184A Fluorescent Whitening Agents and Their Behavior in Paper Manufacture
A. J. Hinton

187A **Sustaining Members and Advertisers**

COMING EVENTS:

National Conferences

Forty-seventh Annual Meeting
Commodore Hotel, New York, N. Y.
Feb. 18–22, 1962

Thirteenth Coating Conference
Netherland-Hilton Hotel,
Cincinnati, Ohio
May 14–16, 1962

Thirteenth Testing Conference
Benjamin Franklin Hotel,
Philadelphia, Pa.
Sept. 18–20, 1962

Seventeenth Plastics-Paper Conference
Statler-Hilton Hotel, Boston, Mass.
Oct. 8–11, 1962

Seventeenth Engineering Conference
Queen Elizabeth Hotel, Montreal, Que.
Oct. 14–19, 1962

Twelfth Corrugated Containers Conference
Statler-Hilton Hotel, Boston, Mass.
Oct. 23–26, 1962

Sixteenth Alkaline Pulping Conference
DeSoto Hotel, Savannah, Ga.
Oct. 31, Nov. 1–2, 1962

Please refer to Local Section Activities for the locations and dates of Section Meetings

Tappi

NOVEMBER CONTENTS — *continued*

PRESIDENT

H. M. Annis
Oxford Paper Co.
230 Park Ave., New York 17, N. Y.

VICE-PRESIDENT

J. C. Wollwage
Kimberly-Clark Corp.
Neenah, Wis.

EXECUTIVE SECRETARY

P. E. Nethercut
Technical Association of the Pulp and Paper Industry
360 Lexington Ave.
New York 17, N. Y.

TREASURER

R. G. Macdonald

PUBLICATIONS COMMITTEE

J. C. Wollwage
W. C. Bloomquist
G. C. Kimble
W. P. Lawrence
H. A. Spencer

EDITORIAL BOARD

C. B. Christiansen
J. V. Cundelan
R. A. Dando
C. P. Donofrio
R. E. Durst
John Frankevicz
J. W. Gilbert
R. S. von Hazmburg
M. S. Kantrowitz
E. G. Locke
G. G. Maltenfort
E. F. Manogue
R. C. Masterman
M. N. May
R. H. Mosher
W. W. Roehr
J. R. Sanborn
J. E. Sapp
F. R. Sheldon
H. A. Spencer
H. W. Stevens
J. F. Theriault
J. Weiner

ASSOCIATION SECTION

12A **Opportunities Unlimited**
A. G. Sharp

22A **Development of Useful Products from Kraft Lignin**
Paul R. Wiley

95A **Association News and Events**

96A Twelfth Testing Conference report

107A Eleventh Corrugated Containers Conference report

108A Third TAPPI—ASQC EVOP Course report

109A Fourth International Mechanical Pulping Conference report

116A **TAPPI Notes**
Reference Materials for Testing

117A **TAPPI Profile**
G. W. E. Nicholson

119A **Personal Mention**

Industry Notes

122A Paper Manufacturers and Converters

138A Educational Institutions

139A Industry Suppliers

148A General

Divisions and Committees

149A Authorized Committee Projects
Converting and Consuming Division

Divisions and Committees, *(Continued)*

149A Plastic Laminates Committee

Engineering Division

150A Fluid Mechanics Committee

Research and Development Division

151A Microbiological Committee

Testing Division

152A Paperboard Testing Committee

154A **Employment Service**

Local Section Activities

156A Meeting Calendar

157A 1960–61 Activities of the Italian Section

159A **United States Patents on Papermaking—Second Quarter 1961**
Compiled by The Institute of Paper Chemistry

Papers of Current Interest

173A Precast Clay Coating
Frank D. Bergstein

175A The Examination of Boxboard Samples for Trace Quantities of Heavy Metals
Walter F. Weiss and Edward C. Stivers

176A Defining and Solving Toxicological Problems Related to the Pulp and Paper Industry by Use of Radioisotopes Techniques
Frank J. Dominiques and D. H. Andersen

178A Newsprint Quality Control
Vincent N. DeFelice

181A Development and Application of the Kopparfors Lining
Ray A. Menges, Ame Ahlstrom, and S. Olsson

184A Fluorescent Whitening Agents and Their Behavior in Paper Manufacture
A. J. Hinton

187A **Sustaining Members and Advertisers**

COMING EVENTS:

National Conferences

Forty-seventh Annual Meeting
Commodore Hotel, New York, N. Y.
Feb. 18–22, 1962

Thirteenth Coating Conference
Netherland-Hilton Hotel,
Cincinnati, Ohio
May 14–16, 1962

Thirteenth Testing Conference
Benjamin Franklin Hotel,
Philadelphia, Pa.
Sept. 18–20, 1962

Seventeenth Plastics-Paper Conference
Statler-Hilton Hotel, Boston, Mass.
Oct. 8–11, 1962

Seventeenth Engineering Conference
Queen Elizabeth Hotel, Montreal, Que.
Oct. 14–19, 1962

Twelfth Corrugated Containers Conference
Statler-Hilton Hotel, Boston, Mass.
Oct. 23–26, 1962

Sixteenth Alkaline Pulping Conference
DeSoto Hotel, Savannah, Ga.
Oct. 31, Nov. 1–2, 1962

Please refer to Local Section Activities for the locations and dates of Section Meetings

Let TITANOX-A-CG help make sales through the mails

The eagerly awaited catalog can be a star salesman, especially when well known TITANOX titanium dioxide pigment has boosted the brightness and opacity of its pages while keeping weight down. And for outstanding pages that require coated stock there is new TITANOX-A-CG.

TITANOX-A-CG is the coating grade anatase titanium dioxide pigment so well suited to the high solids, high speed coatings applied by all modern coating methods including the trailing blade coater. This pigment is equally suitable to other processes such as size press and calender application.

In addition to high whiteness, brightness and opacity, TITANOX-A-CG readily yields high gloss. This pigment is ideal for the fast, continuous production of paper surfaces of uninterrupted smoothness.

We will be glad to discuss with you the type of TITANOX best suited to solve your white pigmentation problems. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; offices and warehouses in principal cities. In Canada: Canadian Titanium Pigments, Ltd., Montreal.

TITANIUM PIGMENT CORPORATION
SUBSIDIARY OF NATIONAL LEAD COMPANY

TITANOX

7696

These Hands at HUYCK...

. . . . have more than a quarter of a century of experience in sorting and selecting wools. This and the other hand skills essential to feltmaking are augmented increasingly by Huyck's scientific instruments and techniques to assure uniformly high quality for the papermaker.

Experience, craftsmanship and technical "know-how" are reasons why Huyck's Performance is High Performance in the papermaking industry.

HUYCK FELTS

Huyck Felt Co., Rensselaer, N. Y.; Aliceville, Ala.

Division of Huyck Corporation

In Canada: Kenwood Mills Limited, Arnprior, Ontario

FIRST IN FELTS SINCE 1870

Celebrating 75 Years of Service to the World's Pulp and Paper Industry

WOOD PULP
PULP PAPER EXPORT

GOTTESMAN-CENTRAL NATIONAL ORGANIZATION

100 Park Avenue, New York 17, N.Y. • Gottesman & Company, Inc. • Central National Corp.
Central National Commercial Co., Inc. • Gottesman & Company Akt., Stockholm
Central National-Gottesman Ltd., London • Representatives in 75 World Markets

GOODYEAR

Photograph taken with cooperation of The Sorg Paper Company, Middletown, Ohio, and American Tag Company, Chicago, Illinois.

They ended the "deadlocks"—cut labeling costs 52%—with CHEMIGUM LATEX!

An annoying problem for meat packers was labeling hot, freshly skinned beef. Ordinary labels wouldn't stick. Notations were blurred by the grease. The only answer was tags applied with metal "deadlocks" or hooks—a costly, time-consuming operation.

A cheaper, better solution was found, however, in paper impregnated with CHEMIGUM LATEX. Its toughness plus resistance to grease and moisture—over a range of temperatures—permitted labels that remained in place, intact and clearly legible, yet peeled off cleanly. That ended the deadlocks at a healthy 52% savings in label costs.

How can CHEMIGUM LATEX beef up your paper product? Unusual toughness, flexibility, tear strength, and resistance to moisture, oil, solvents and chemicals are some of the properties you get—easily and economically—through beater impregnation or saturation with CHEMIGUM LATEX. For samples, assistance, or *Tech Book Bulletins,* write: Goodyear, Chemical Division, Dept. K-9432, Akron 16, Ohio.

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemigum—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Opportunities Unlimited

A. G. SHARP

THE printing and writing paper business, like most businesses today, is experiencing rapid changes. We see changes taking place in the technology of both the manufacture of paper and the graphic arts processes using paper; changes in the variety of end markets and in their paper requirements; and changes in the means of distributing products to those markets. The rate of change in the paper business today is more rapid than at any time in our history.

The growth and diversification of paper companies in grades of paper produced and in markets served; the movement of paper manufacturers into the fields of converting and distribution; the mergers and developments in the graphic arts industries and in the broad field of communications, all point toward more complex paper marketing processes, and to more critical requirements for coated papers as a printing medium.

It has been said, "There is no such thing as a growth industry; there are only companies organized and operated to create and capitalize on growth opportunities."*

How can—or will—coating researchers and technicians, paper marketing people, and corporate executives create and capitalize on opportunities in our changing business to keep our companies growing profitably?

The first and still the most important use of paper is communications.

Communications, and the means of communication, have become complex and varied with the growth of our society. However, the basic need of communications—to transmit knowledge—is the same. Paper for printing and writing has been and still is the essential commodity in the communications market.

From clay tablets—which were cumbersome to carry and likely to deteriorate in storage—we have progressed to clay coated paper for printing—and today to specially coated paper for recording knowledge electronically.

An outstanding technological development in the production of printing paper during the first half of this century was coating on the paper machine.

"Output of machine-coated paper in 1960, at 1.9 million tons, exceeded for the first time the combined tonnages of uncoated book printing and uncoated groundwood printing paper grades. This development is particularly remarkable in view of the fact that only 15 years ago the output of uncoated printing papers was three times larger than machine coated paper."

"The meteoric rise of machine coated paper has contributed substantially to the tonnage output gains of the paper industry since the end of World War II. The 1.6 million ton increase in machine-coated paper since 1945, has far outstripped the tonnage output gains reported for any other paper grade."†

The market force generating the development and growth of machine-coated paper was the need for a smoother printing surface, with better ink receptivity for high-speed printing, all at a more economical cost. Demand for machine coated papers in magazines and advertising materials has been the strong influence in the 475% growth in tonnage for this type of paper since World War II. With improved techniques, machine coated papers have been developed for all types of printing processes and for every end-use of printed materials.

Off-machine coated paper ranged between 200,000 and 300,000 tons during the last 15 years. Thus total coated paper production reached a new high or almost 2.2 million tons in 1960.

Of this 2.2 million tons, around 2.0 million was coated two side paper and about 200,000 was coated one side paper.

The demand for coated printing papers today is basically tied to advertising—advertising in consumer and trade magazines, direct mail promotion pieces, circulars, catalogs, and numerous types of printed pieces.

Magazines still comprise the major market for coated printing paper, consuming around 70% of the coated two side paper, or roughly 1.4 million tons in 1960.

About 25%—Some 500,000 tons—of the coated two side paper was used in commercial printing, both letterpress and offset, principally for advertising and promotional material.

The balance of 5%, or roughly 100,000 tons, was used for books, for converted paper items, and for other end-uses.

Almost all the coated one side paper is used for labels and wrappers.

Total magazine circulation shows only a moderate long term growth.

The magazine industry's share of advertising expenditures improved somewhat in 1959 and 1960 in comparison with other media, but over the long term, magazine advertising volume has not gained in relation to total consumer spending. Competition for share of advertising volume will continue to be severe among magazines as well as between magazines and other media.

While there will continue to be expansion of tonnage in the magazine publication field, this market seems to offer less opportunity for rapid growth in the future than in the last 15 years.

Most other segments of the printing industry are growing at faster rates than magazines, for example, commercial printing, book publishing, and greeting cards.

A. G. SHARP, Kimberly-Clark Corp., Neenah, Wis.

* "Marketing Myopia," by Theodore Levitt, *Harvard Business Review*, July–August, 1960.

† U. S. Department of Commerce, "Pulp, Paper, & Board Report," January, 1961.

make a
better paper
with

R·T·VANDERBILT COMPANY, INC·N·Y·
AMERICAN PRODUCTS

Bilt-Wax®

IMPROVED WAX EMULSIONS

FOR

hard board

magazine—liner

carton stock—insulation board

details on request

R. T. VANDERBILT COMPANY, INC.

230 PARK AVENUE • NEW YORK 17, N. Y.

Coated printing papers will have to diversify more strongly into other printing and communications markets in order to continue their past rate of growth.

With more diverse end uses, a wider range of papers will be required—grades for specific printing processes, for special inks, and with added special functional properties for unique and varied reproduction applications.

Paper coating technology faces these broad challenges —or opportunities—in the communications markets:

1. To hold or expand the use of coated printing paper for present applications in the magazine publishing and the advertising fields.
2. To move coated printing paper more strongly into printing markets it has to date only slightly penetrated.
3. To develop specialized types of paper to meet the increasingly complex communication needs of our society.

Let's consider more specifically some of these challenges—or opportunities—that already exist in today's market:

The magazine publishing industry is in a period of dynamic experimentation. It is seeking to regain position lost to competing advertising media. A general industry promotion and public relations program, regional advertising, split runs, special attention-getting bindery innovations such as cut-outs, tip-ins, and fold-outs, new engraving and printing processes providing unique effects, all offer a challenge and hold out a promise for magazine publishers.

Reduced cost for equal or improved quality and performance is the first and foremost challenge facing printing paper for the magazine publishing market. Paper producers and publishers have been concerned about rising costs. Their advertisers, however, continue to increase demands for improved paper quality and improved quality of printing reproduction. Lower cost methods of coating and lower cost coating materials, which will still provide printing surfaces and press runnability equal to or better than today's machine coated publication papers, are goals we should all be striving for.

With rising postal rates and freight costs, magazine publishers are giving increased attention to the savings that can be made by the use of lighter weight papers. This also provides a challenge—or an opportunity—for the coating technologist to provide the lighter weight papers with equal or better opacity, strength, and printing performance.

Unique effects through the use of special coatings are being sought by magazine advertisers to help break the sight barrier in the terrifically competitive consumer advertising market. More goods are being produced and more services are being created and more new products being developed by our economy than ever before—and they are all being advertised more heavily. If coated papers can meet these challenges, magazines will be better able to perform a dynamic role in mass advertising.

Quality printing papers with improved resistance to aging are needed by the increasing volume of historic or heritage type publications.

Colored paper is attracting increased interest from magazine publishers. At present, it is used chiefly for limited editorial summary sections, but considerable psychological research is being done to determine its effect on the perception of printed communications. Again coating technology can and should capitalize on these opportunities—meet these challenges.

In commercial or job printing, the shift from sheets to rolls is one of the most significant changes. The trend to the use of heat-set web offset and rotary letterpress printing on commercial printing jobs requires top quality papers which will perform satisfactorily on the heat-set presses.

Even on sheet-fed presses, higher speeds demand faster drying, better ink receptivity, greater flexibility, and uniformity. New inks and new color processes used by printers demand closer integration of paper, ink, and printing process.

Special coatings and mechanical treatments are likewise being sought by commercial printers to provide unique and outstanding graphic effects. More and more use is being made of metallic coatings, fluorescent coatings, textured coatings, etc. These all are challenges—or opportunities—for the coating technologist.

The traditional coated printing paper markets—basically, printed advertising through magazines, catalogs, brochures, and direct mail—will continue for some time to provide the major usage for coated printing paper. However, there are other segments of the print communications market which are growing faster today and which offer paper coaters new opportunities to contribute new and improved print media.

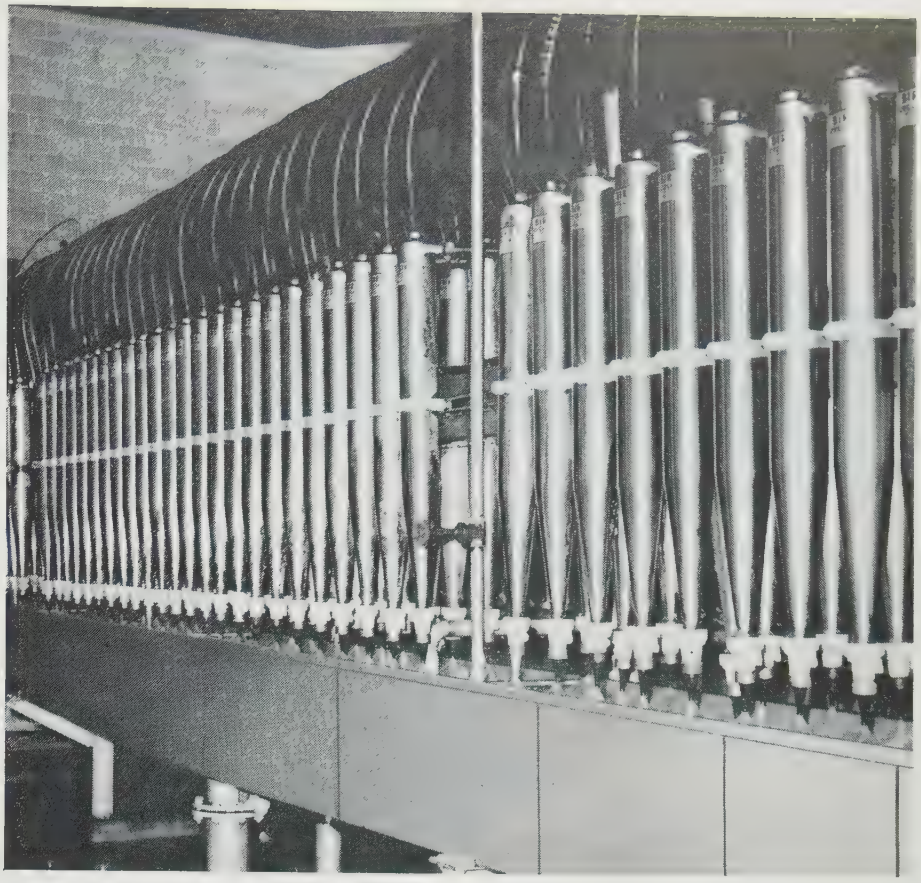
For example, the book publishing business has been pressing along at a rapid rate in the years since World War II. Paced by the sale of more than a million paperbacks a day, book sales reached a total of about one billion books last year. With increasing emphasis on higher education, the booming school-age population, greater leisure time, and rapidly changing technology, book publishers look to even greater growth ahead.

One of the most challenging areas for coated papers is in the school textbook market. Coated papers are used only sparingly in this market today. However, the development of new and different educational book design to go along with new and improved educational methods could change this historic pattern. The growth of the work book exemplifies a change in types of educational books. Also notable is the increasing use of halftone pictures with more and more detail.

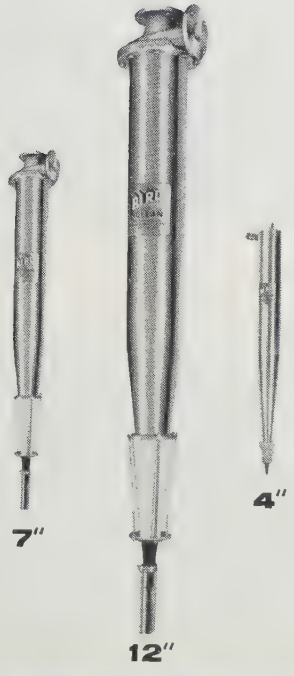
A longer range possibility is that of low cost "disposable" books, combining both text and work book features, designed for a single year's use and retention by the student. I am sure coating technology has an opportunity here to provide the improved characteristics and new types of paper that are needed for the new textbook designs and requirements.

With the present emphasis on improvement of education, not only textbooks, but teaching methods and learning systems are in an experimental development period. Teaching machines, televised programs, recording devices, and various types of teaching and learning systems are being tried and developed. All of these require some print media in their use as educational aids, even if it is nothing more than instruction sheets. Paper can continue its major cultural role in our society if we understand the changing needs of education and creatively develop products to meet those needs, not only in the traditional way through books, but also in conjunction with the new teaching

Is YOUR Stock As CLEAN



As BIRD CYCLEANS Can Make It?



Today there is hardly a kind, grade or volume of pulp and paper stock that cannot be *cycleaned* to better its quality, uniformity and salability. Reduction in shive and speck count is always substantial — often extraordinary.

Capacity per Cyclean ranges from 36 to 850 gpm. Advanced, modern design virtually eliminates operating and maintenance problems. The small diameter Cycleans may be equipped with *patented automatic purge tips* that do not plug. The larger diameter Cycleans are of special *baffle head* construction that prevents ingress of air. *Sintered ceramic* cone sections and tips defy wear.

Ask us to recommend the Cyclean set-up that will make you the most efficient and economical clean-up.

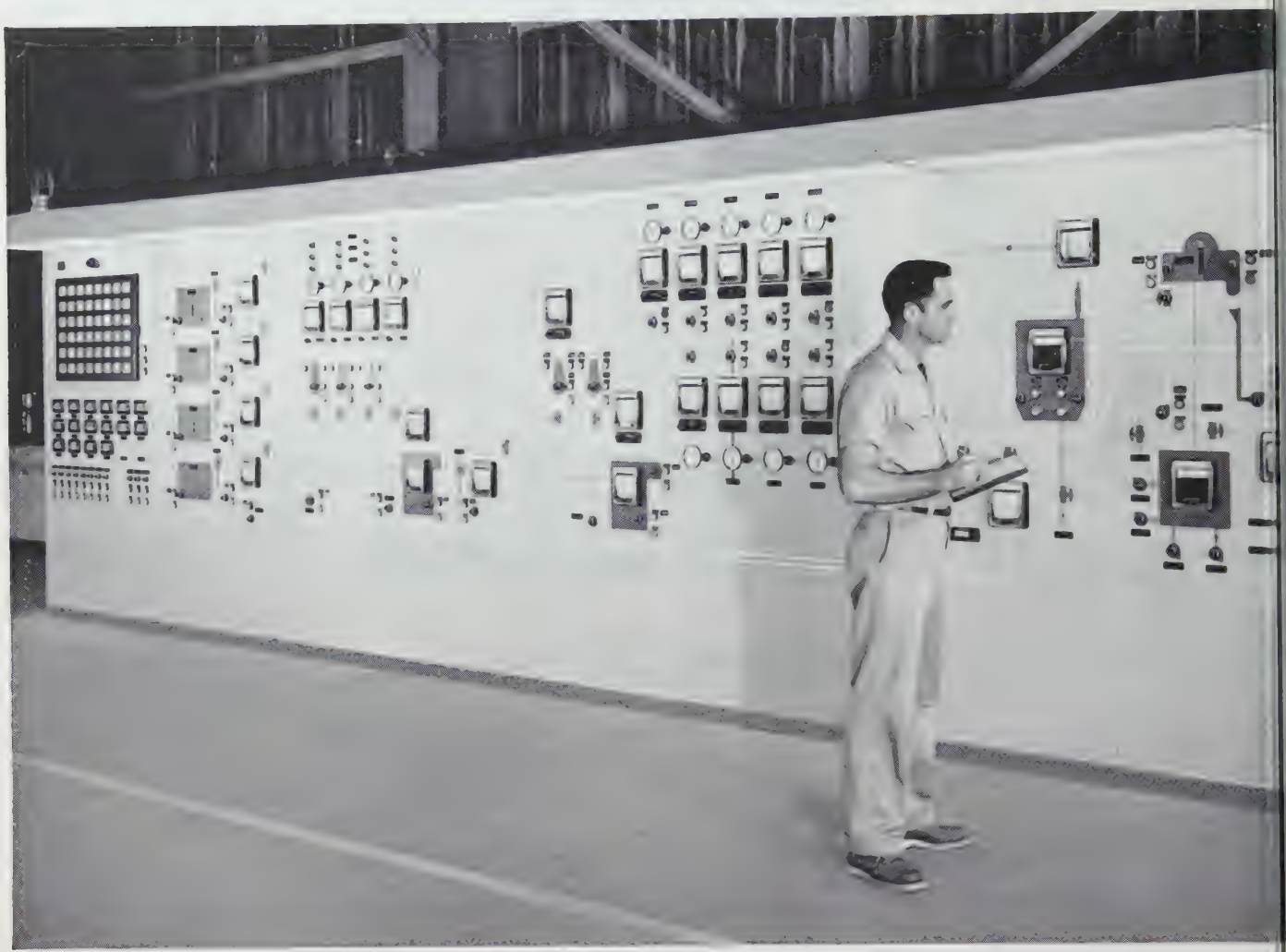
BIRD MACHINE COMPANY

SOUTH WALPOLE, MASS.

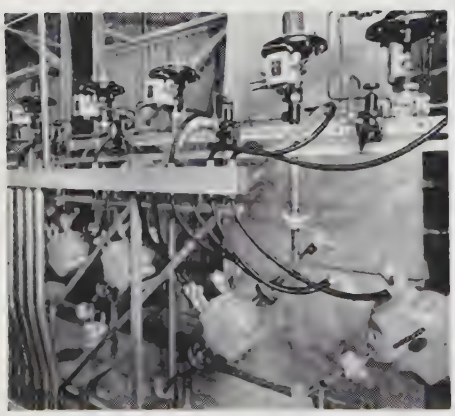
REGIONAL OFFICES: EVANSTON, ILLINOIS
PORTLAND 4, OREGON • ATLANTA 9, GEORGIA

Canadian Manufacturers of Bird Machinery
CANADIAN INGERSOLL-RAND COMPANY, Limited, Montreal

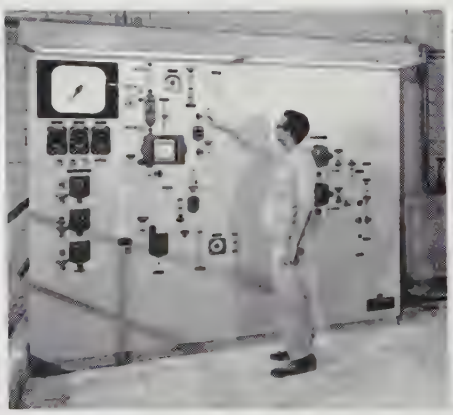
Marathon Southern Using on New Board Machine



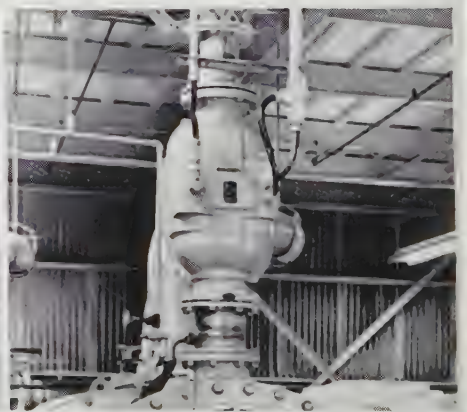
FOXBORO STOCK BLENDING PANEL automatically proportions 3 stocks, 2 dyes, and 10 different additives. Machine tender just sets dials and walks away. Foxboro does the rest — even readjusting flow rates to meet changes in machine demand, while holding proportions constant.



FOXBORO ½-inch and 1-inch Magnetic Flow Meters control flow of dyes and additives to various chests. Meters have no flow restrictions — never foul or plug up.

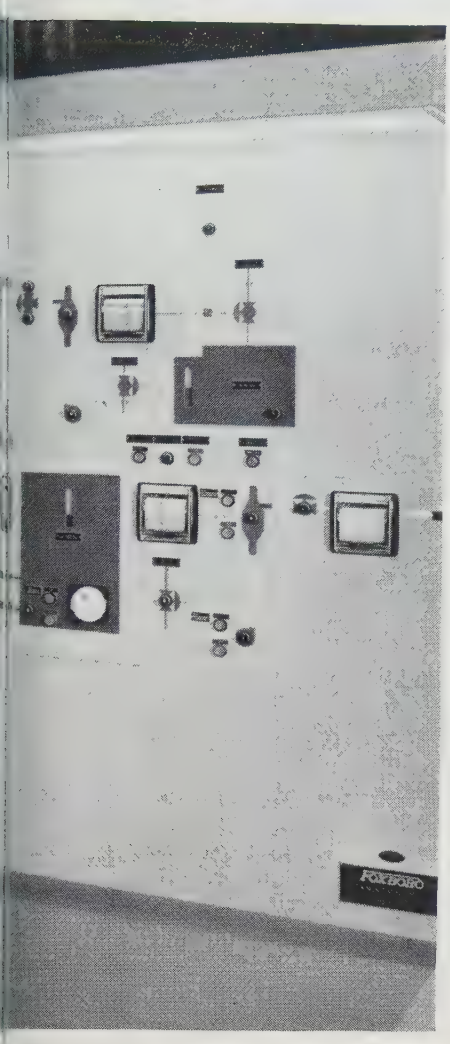


FOXBORO TRAILING-BLADE COATING MAKE-UP CONTROL PANEL automatically controls weighing, mixing, and blending of coating materials in accordance with pre-determined ratios.



8" FOXBORO MAGNETIC FLOW METERS keep continuous check of flow of stock from intermediate Claflin Refiners. If flow is excessive, warning lights on control panel attract operator's attention.

Foxboro Control at Naheola, Alabama



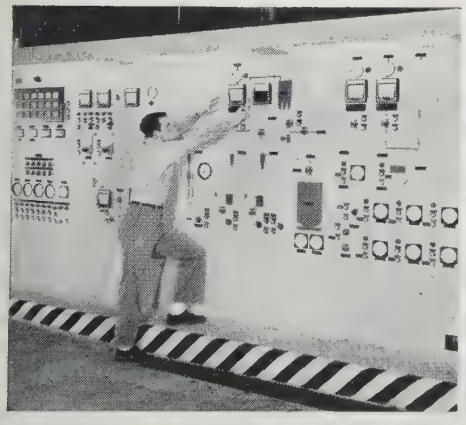
Foxboro engineering provides finger-tip control in new expansion project

Marathon Southern Corporation's new board machine is believed to be the most completely automated in the industry. Stock preparation, dry-end control, suction-box vacuum control, trailing-blade make-up, size press coating make-up — all are controlled by individual Foxboro graphic control panels throughout the mill.

The total instrument installation was designed to pay for itself in short order through precise control and reduction of production errors.

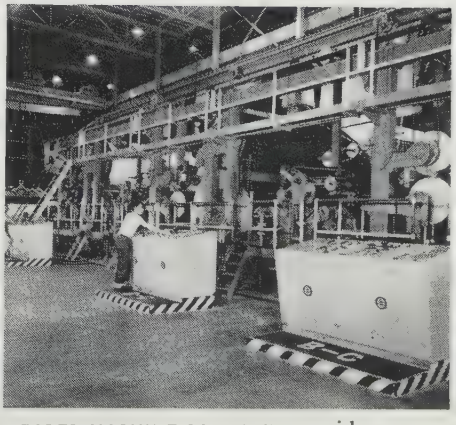
Complete mill, or single process, Foxboro instrumentation can help you make paper and board more efficiently, at lower cost. Ask your nearby Foxboro Field Engineer for details. The Foxboro Company, 7811 Neponset Avenue, Foxboro, Massachusetts.

FOXBORO
REG. U.S. PAT. OFF.

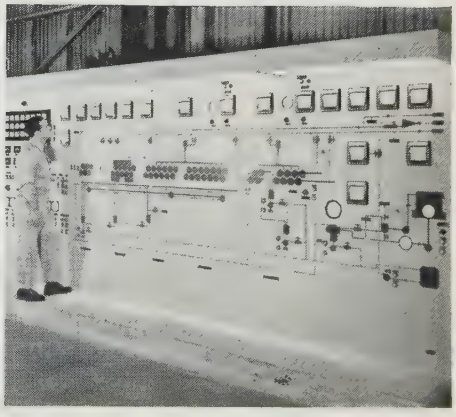


FOXBORO WET-END CONTROL PANEL. Small-case Consotrol* instruments, and graphic panel techniques were used throughout the mill. Marathon reports them a great benefit in training operating personnel.

**Reg. U.S. Pat. Off.*



PAPER MACHINE CONSOLES provide operators finger-tip control over their mammoth board machine. Machine was designed and built by Black-Clawson Company. Start-up was smooth according to Marathon officials.



FOXBORO DRY-END CONTROL PANEL. All instrument systems were designed with Foxboro engineers, working in close cooperation with Marathon's contracting engineers, Rust Engineering of Pittsburgh.

methods and devices. The need will be there; if paper does not meet the need, other materials and products will. Will coating technologists be a factor in retaining this as a growth opportunity for paper?

The increasing tempo and complexity of office activities in business and government has generated the development of a vast array of business machines—machines for the transmission and recording of information, for computing and compiling data, and for control of operations.

"Glamour Girl Friday of the office equipment industry these days is the copy machine. Copy machines get more and more attention as their manufacturers bring out new processes and streamlined desk size copiers. Yet the production and sale of office-copying machines is still in its childhood as a business, for its boom began just eight years ago."‡

The need for office copies is an old one, but the methods of obtaining them are changing. Opportunities exist for new types of paper with specialized coatings as print media for the office copying market.

New processes and systems are evolving for the transmission of graphic communications, including pictures, over long or short distances. One of the approaches, considered primarily for long-distance communications at present, uses various methods of electronic scanning and is generally referred to as facsimile transmission. It is now in use to a limited extent, and is generating much interest as a copier, as well as a transmission device, for both local and distant communications. A recent innovation is a special paper for the receipt of facsimile transmission from which the message temporarily disappears immediately after recording, then reappears later at a given time. This might be a boon to both military and business operations of a confidential nature.‡

Facsimile transmission and office copiers do not yet challenge the printing presses or traditional copy machines. However, if technological improvement continues at its present rate, copying and transmission speeds several times those of today's machines can be expected in the next few years.

Office managers and copy machine manufacturers both visualize office copiers that will transmit and produce copies at several distant points simultaneously—providing the required multiplicity of copies and at the same time speeding up their distribution over the present mailing systems.

‡ "Speed Up in Office Copying," *Ind. Res.*, December, 1960–January, 1961.

There seems to be a particularly pertinent opportunity to provide special functional properties via coating in this copying and facsimile transmission field.

I believe that opportunities for new and different types of papers are present in the rapidly expanding field of automatic data processing and control equipment. The electronically computed output is of little value without some kind of print medium for transmitting the information to people. Nor can the machines operate without an input of data usually provided by some type of "print" medium. Whether these print media will be paper products or some other material represents a challenge and an opportunity to the paper industry. Can it be solved by coating technology?

Another interesting field of experimentation and development is that of encapsulation or "capsule" coating. Probably the best known capsule-coating application today is in the no carbon required (or NCR) paper. Other possible applications of encapsulation might be in facsimile transmission or through the use of a triad capsule system, we might develop a new method for color reproduction. The NCR application employs mechanical pressure as the stimulus. What if we use encapsulated materials which are sensitive to light, to heat, to different chemicals, or to various electronic stimuli? Coating research and development in this field could open up exciting possibilities for the use of paper in tomorrow's communications needs.

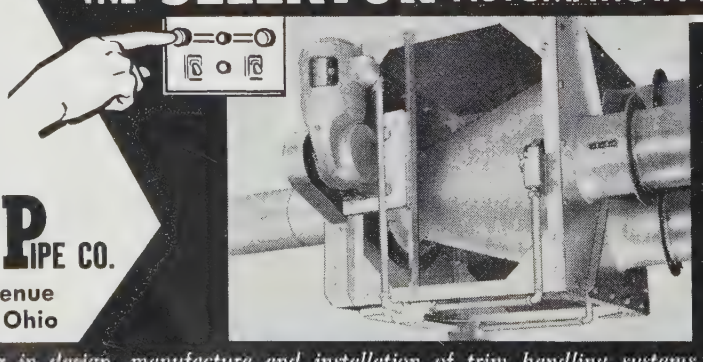
Paper faces challenges from many quarters in the communications field. New transmission processes and systems, new methods of printing and reproduction, new inks, new coatings, and new developments in print media will all play a part in the evolution of the communications market. The paper coating industry must keep abreast of and understand all modern communications requirements; and it must be inventive in the development of products to fill the print media needs. If the paper industry—with its coating technologists—does not meet the challenges and capitalize on the opportunities in the communications markets, we can rest assured that other industries will.

The challenges are great—but the opportunities are unlimited—and the talent is here—to assure that our paper industry will continue to serve the needs of our civilization and culture by contributions to improved communications.

Presented at the 12th Coating Conference of the Technical Association of the Pulp and Paper Industry, held in Buffalo, N. Y., May 8–10, 1961.

a new cost saving product from
OHIO BLOW PIPE CO.
1728 Doan Avenue
Cleveland 12, Ohio

THE SELEKTOR AUTOMATIC IN-LINE PAPER TRIM GRADER



IDEAL TO MODERNIZE ANY EXISTING PAPER WASTE HANDLING SYSTEM.

A NECESSITY IN NEW INSTALLATIONS TO GAIN MAXIMUM EFFICIENCY.

- A single pneumatic pipe feeds into SELEKTOR. Desired discharge outlet is selected by remotely located push button panel.

The leader in design, manufacture and installation of trim handling systems

What has latex done for these books?

Latex from the laboratories of Naugatuck Chemical has given these books a better cover at less cost.

Good looks and excellent printability are but two obvious qualities of these LEXIDE* covers made of latex bonded cellulose fibers. Compared with other popular cover materials costing from 36% to 63% more, a leading independent testing laboratory had found Lexide had more than 6 times the flexing endurance. better than twice the scrub resistance. and 3 times the abrasion resistance of the more expensive materials!

In cover stock for everything from the heaviest reference books to thin passport folders, in pulp and paper applications of every description, paper chemists with the help of Naugatuck Latex have demonstrated their ability to improve quality, add special characteristics, and often reduce product cost at the same time.

If you are interested in the possibilities, a Naugatuck latex or compound offers you, (and you should be), contact us today at Naugatuck Chemical, Naugatuck, Connecticut.

Latex Fiber Industries, Inc. Beaver Falls, New York

NAUGATUCK CHEMICAL DIVISION **United States Rubber**

DEPT. A ELM STREET, NAUGATUCK, CONNECTICUT

DISTRICT OFFICES: Akron · Boston · Portland · San Francisco · Chicago · Detroit · Gastonia · Los Angeles · Memphis · New Brunswick, N. J. · Latex Division, Dominion Rubber Company, Ltd., Montreal · CABLE: Rubexport, N.Y.

Tinopal... the standard for optical whiteners

A specific product for each grade of paper

Tinopal 4BMA Liquid or Powder
Tinopal BX Liquid are suggested for unsized paper where high substantivity is required.
Also on sized paper where minimum of electrolytes are present. Excellent for clay coated papers.

Tinopal PW 300%
Tinopal P Liquid are highly recommended for size press application.
Its moderate substantivity permits running in lower pH range with uniform results in the presence of built up electrolytes.

Tinopal 3BSA Liquid or Powder is suggested for paper in the medium pH range of 5.5 to 7.0.
Useful on sized or unsized papers.

Tinopal 2BFA Liquid is the least substantive of the whiteners and is useful on paper run in lower pH range of 4.0 to 5.0 where maximum electrolytes are present.

Our technical staff shall be glad to survey your needs on optical whiteners and suggest the one best suited to your needs.

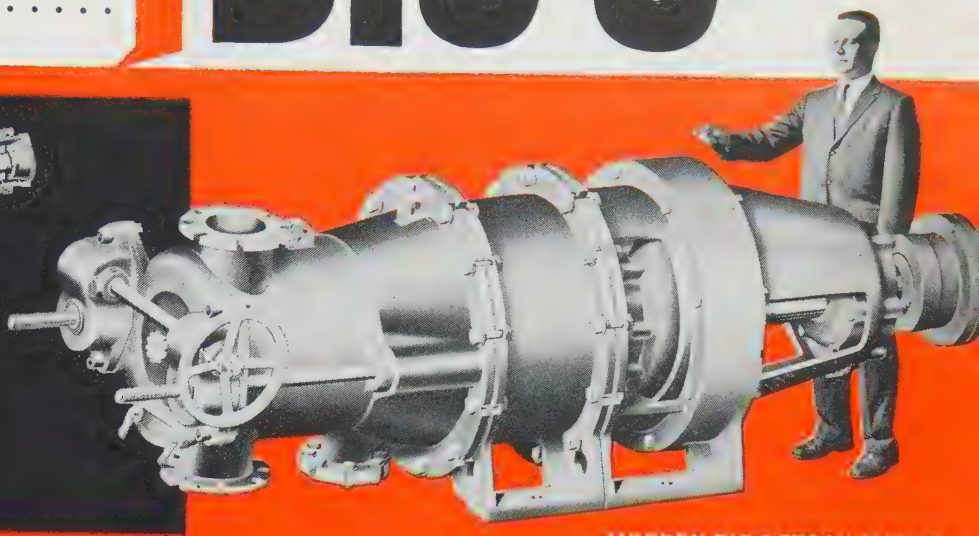
Geigy Dyestuffs

- *Big Capacity*
- *Improved Treatment*
- *Operating Economy*

with the Morden . . . . .

BIG 8 REFINE

FIGURE 5. Big 8 Stock-Maker Refiner, illustrating reverse flow, cushioning principle. Stock enters hollow rotor at A, is forced between bars on rotor B and shell C where the opposing internal flow pressures hold a full cushion of stock, permitting heavy bar loading for maximum brushing, combing and fraying of the fibers. Cutting action is at a minimum.



MORDEN BIG 8 STOCK-MAKER
300-400 CONNECTED H. P.

FIGURE 1. Untreated pulp. Freeness, 635 Canadian Standard. Tear factor, 85.

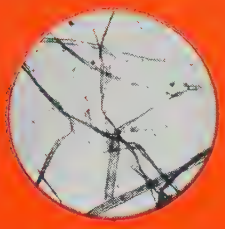


FIGURE 2. Medium treatment by Morden Stock-Maker. Freeness, 300 Canadian Standard. Tear factor, 85.

FIGURE 3. Medium jordaning treatment. Freeness, 275 Canadian Standard. Tear factor, 55.

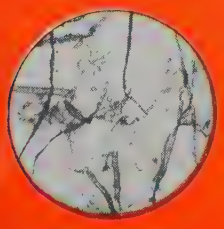


FIGURE 4. Heavy treatment by the Stock-Maker. Freeness, 75 Ca

The perfect refiner is yet to be built. But, the development which comes closest to refining perfection, customers tell us, is the MORDEN BIG 8 REFINER. Here is the BIG MORDEN 300-400 H. P. engine which provides the maximum in stock treatment. . . . Good Mullen • Improved tear retention • Excellent fold and tensile development • Printability specs met with ease through precision stock treatment.

THE SECRET IS MORDEN'S DEVELOPMENT OF THE FIBERS. The incompatibles, Good Mullen and Good Tear Retention at Minimum Freeness Reduction, are made compatible in the MORDEN BIG 8 REFINER through its brushing, combing action, which develops and frays the fibers with minimum cutting. The photomicrographs tell the story. FIGURE 1 shows unbleached sulphite prior to refining. FIGURE 2, the same fibers after medium treatment in the Morden Stock-Maker Refiner. Note the fraying and brushing imparted to each fiber. FIGURE 3, the same fibers treated to about the same level of freeness with a jordan. Notice how the fibers are cut, not frayed. FIGURE 4, the same fibers as Figure 2, except that the MORDEN refining treatment has been carried to much lower freeness. Even so, the tear in Figure 4, with twice as much MORDEN treatment, is better than figure 3 with medium jordaning.

HOW FIBER DEVELOPMENT IS ACHIEVED AND CUTTING MINIMIZED. Morden's unique reverse-flow principle, with opposing internal flow pressures, **provides a constant cushion of stock between the shell and rotor bars,** permitting maximum brushing and fraying, with minimum cutting of the fiber. SEE FIGURE 5. Result: GOOD MULLEN and EXCELLENT TEAR RETENTION at MINIMUM FREENESS DROP, INCREASED MACHINE SPEED & DRYER CAPACITY FOR INCREASED DAILY PRODUCTION.

POWER SAVINGS. Over and over again customers tell us that Morden Stock-Makers provide better stock treatment, yet consume less power . . . **in some cases savings up to 50% are reported.** A 400 H. P. MORDEN BIG 8 uses only 70 to 90 of its connected H. P. for idling load, leaving 310 to 330 H. P. for efficient stock treatment. Compare this efficiency with any other conical refiner, where usually up to 50% of applied energy is consumed for idling load.

LOWER INVESTMENT COST. When all other costs are going up, Morden has improved the design, retained the efficiency but has reduced the cost approximately 20%. Built-in motor is a cost and space-saving option.

LOWER MAINTENANCE COST. Chrome steel fillings are recommended for furnishes in a pH range of 6 or above. Bronze fillings in furnishes with pH 6 and below. Fillings usually give 3 to 5 or more years of trouble-free service. Precision-machined cast fillings require no grinding-in. Down time cut to a minimum. Constant load maintained easily. Superior fillings and fine machine design result in minimum maintenance.

Mordenize . . . . .

YOUR STOCK SYSTEM

. . . send for full information on the MORDEN BIG 8 REFINER.

MORDEN
MACHINES COMPANY
3420 S. W. MACADAM AVENUE
PORTLAND 1, OREGON
TELEPHONE: CAPITOL 2-9355 • CABLE: "MORDEN"

Development of Useful Products from Kraft Lignin

PAUL R. WILEY

Kraft lignin constitutes the largest source of raw lignin available in this country. The structural features of kraft lignin which make it susceptible to sulfonation, esterification, etherification, salt formation, aldehyde condensation, halogenation, and other reactions are well known. However, the relative quantities of active groups, as well as the average molecular weight of the lignin, varies depending on wood source and processing conditions. Standardized derivatives have been developed from raw kraft lignin starting material. Lignin derived products are of two main types: the first, involving the surface active properties of water soluble salts derived from lignin, includes emulsion stabilization, cement processing, ceramic processing, dye dispersion, insecticide dispersion, pigment dispersion, and others. The second type of use, in which the lignin derived product becomes integral with the end product in large percentage, includes the use of newly developed products in resins and in rubber. Although the above developments are far from consuming the total raw kraft lignin available, they demonstrate what can be done by the application of time and money to lignin as a raw material.

THE ready availability of lignin as a potential chemical raw material has led to countless ideas for its commercial utilization, but relatively few of these ideas have reached actual fruition. Much of the previous work has been necessarily superficial because of reluctance on the part of most industrial concerns to allocate sufficient research funds to conduct intensive studies on a material as complex in structure as lignin. It is the object of this paper to describe, from the viewpoint of a company which has invested a large amount of time and money in lignin research, the approaches believed to be prerequisite to success in this field.

The first problem comes with the term "lignin" itself. Webster defines lignin as "A substance related to cellulose and with it constituting the essential part of woody tissue." This is very general and desirably so, since the term lignin should be used only to describe a general class of substances occurring naturally in woody plants, rather than related materials obtained by further processing. Too often there has been a tendency to describe as "lignin" such widely varying materials as spent sulfite liquor, lignosulfonates, protolignin, thiolignin, alkali lignin, wood hydrolysis lignin, and many others. This has caused considerable confusion on the part of investigators, particularly potential consumers of products derived from lignin, with the result that such products have gained the reputation of being more heterogeneous than they are. Accordingly, it is of paramount importance to specify clearly the material under consideration. The process from which it originates offers a partial description, i.e., wood hydrolysis lignin, but this is often inadequate, especially when further processing is involved. Since the complete structural formulas of most lignin-derived products are not generally known, it is usually necessary to identify them by code numbers or brand names along with physical and chemical properties. Although this is not an entirely satisfactory solution to the problem, it is a definite improvement.

Having specified the lignin-containing starting material as clearly as possible and having established a reasonable degree of uniformity, it is essential to study intensively its structural characteristics and reactivity as a basis for making modifications tailored to specific end-uses. In most of the previous investigations of structure reported in the literature an attempt has been made to use a starting material as close as possible in structure to protolignin. This has been very worth while, of course, for establishing some basic concepts of lignin formation and constitution in nature. Such forms of lignin, however, are not currently available commercially, nor is there any immediate likelihood that they will become available in the near future at a reasonable cost. In discussing commercial utilization, then, we are limited to such sources as sulfite pulping, kraft pulping, and, in some areas, wood hydrolysis. Accordingly, for purposes of developing products for commercial use, much more emphasis is needed on basic structural studies of the lignin-derived materials available from these sources.

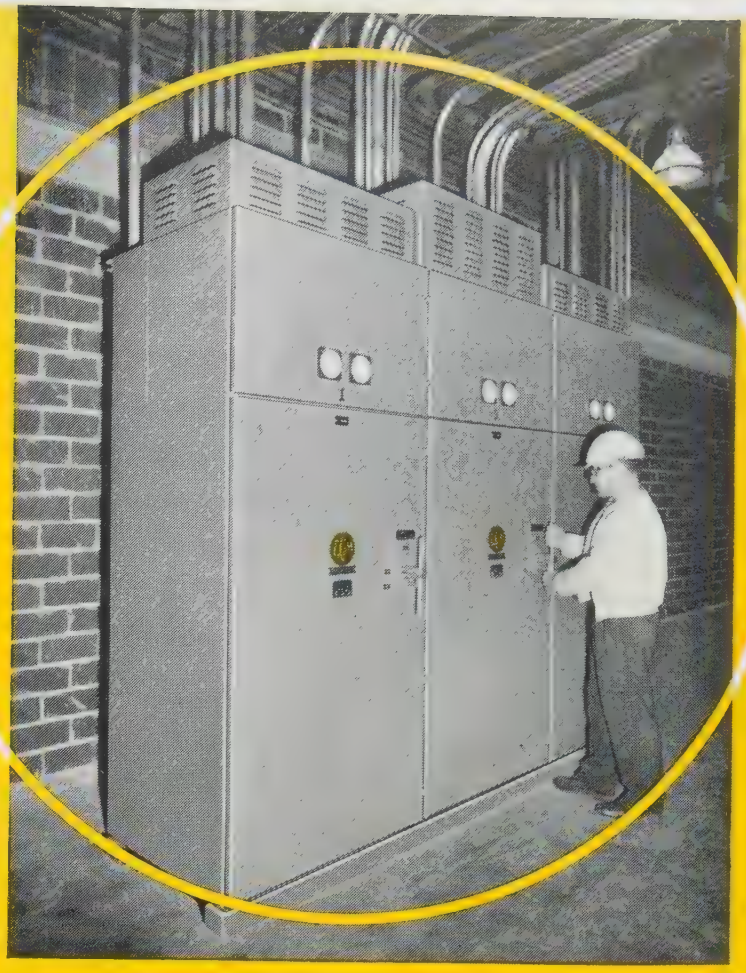
In our company we have confined our work to a kraft lignin starting material, inasmuch as most of our pulping is conducted by the kraft process. In addition to this, the kraft industry represents the largest low-cost source of a given type of raw lignin material available in this country today. It is estimated that at least 6,500,000 tons of kraft lignin are potentially available annually in the United States.

The project of developing processes and uses for products derived from kraft lignin has proved to be expensive and time-consuming. Early lignin studies were conducted in the company as long as 40 years ago, and an intensive program on kraft lignin products has been in progress for 20 years. These various studies have resulted in an outlay of over $5,000,000.

Our initial attempt was to market raw kraft lignin as such, depending on potential consumers to perform the necessary application research. This paralleled the approach used in the earlier successful development of sales for tall oil products by the company. The situation was basically different in the case of tall oil, however, because most tall oil applications were dependent on substitution for chemically similar products already having established markets. Whole tall oil is chiefly a mixture of rosin acids with fatty acids such as oleic and linoleic. Established commercial uses were already in existence for rosin and fatty acids into which tall oil products were able to move rather rapidly on a replacement basis. Relatively little application research was needed in order to stimulate uses for tall oil. Raw kraft lignin, however, was a new material

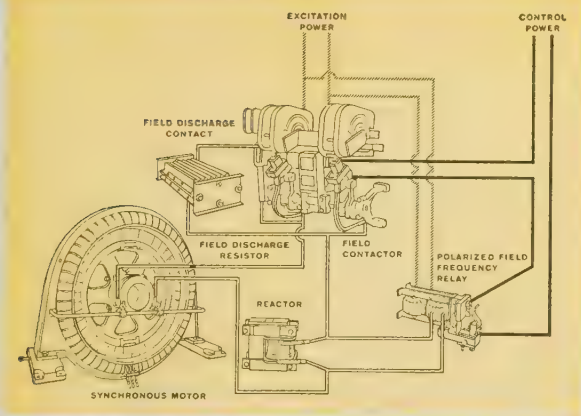
PAUL R. WILEY, Polychemicals Div., West Virginia Pulp and Paper Co., Charleston, S. C.

The Most Complete Synchronous Motor Protection you can buy!



- ***PUSH BUTTON START!***
- ***FULLY AUTOMATIC SYNCHRONIZATION!***

EC&M High Voltage Starters provide Simple, Safe Operation



POLARIZED FIELD FREQUENCY RELAY SYSTEM used in EC&M synchronous starters is noted for its simplicity, dependability, and for fast, positive synchronization at the most favorable time.

A push of the START button gives you complete motor protection, both starting and running—plus EC&M fully automatic synchronization! Motor windings are protected throughout the entire sequence. If the motor slows down, field excitation is automatically removed—the motor is permitted to re-accelerate—and resynchronization occurs automatically when the motor reaches the proper speed. Moreover, short circuit protection is available in both air and oil-break starters for any power system up to 5000 volts.

EC&M synchronous starters give the greatest motor protection plus the simplest operation and the easiest maintenance. They're available in ratings up to 4800 volts, with fuseless or fused interrupting capacity.

Write for BULLETIN 8210. Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

6329

which had no close parallel in industry. Therefore the path of substitution was not open and it was soon evident that extensive application and product modification research would be required. A few minor applications were developed by consumers, but in general the approach of marketing raw kraft lignin as such was not successful.

Accordingly our program of product and application development was greatly expanded. Basic structural information on starting materials and products was especially needed. It is well known that kraft lignins contain phenolic and aliphatic hydroxyl, methoxyl, carboxyl, and ketonic groups, as well as carbon to carbon double bonds, activated hydrogens, and other reactive groups making it susceptible to sulfonation, esterification, etherification, salt formation, aldehyde condensation, and many other reactions. However, the relative quantities of such groups, as well as the degree of depolymerization of the molecule, vary depending on raw material source and processing conditions. Obviously any further processing to make modified products results in still further variations in structure and properties. As background for our product and application research we found it necessary to obtain the services of specialists in lignin chemistry to make structural studies on our own particular raw materials and products. Their studies have since proved to be a very necessary adjunct to our program.

Another necessary phase of this development, as with any operation, concerns process development and control. The high degree of reactivity of raw kraft lignin and its derivatives makes them very sensitive to changes in processing conditions, whether they occur in pulping or in later processing. The process control problems encountered in making cellulose derivatives such as the acetates, nitrates, propionates, and many others are a matter of record. Such problems are no less critical in producing lignin-derived products. We have had to take great pains to develop suitable process control tests and equipment for accurate in-plant control of critical processing conditions.

Finally, in addition to acquiring basic structural information and developing rigid process controls, it has proved especially important to become skilled in the technologies of the major use industries. This was done most quickly and effectively by employing personnel already qualified by training and experience in those industries. In addition to acquiring trained personnel, laboratory and pilot plant facilities often had to be set up to permit adequate servicing of potential consumers. As is well known, new products are very difficult to introduce without extensive data clearly demonstrating their use in terms commonly used in the trade. Since initial difficulties are invariably encountered, the means for studying these problems had to be readily at hand to prevent loss of interest. Ordinarily the consumer is not nearly as anxious to use a given product as the producer is to sell it. Accordingly he will not go to very great lengths to solve the problems which arise.

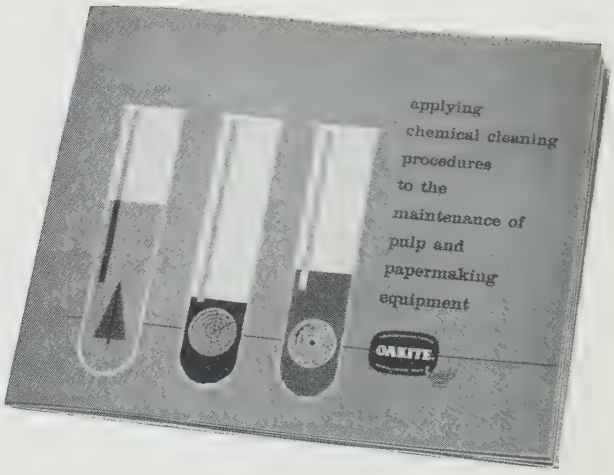
Applications for which we have found it necessary to set up extensive laboratory and pilot plant facilities include ceramics, cement, resins, and rubber. For ceramics this included equipment for pulverizing raw clay, milling it with water and chemicals, pug-milling to remove air, extruding or dry-pressing the body, firing at normal ceramic kiln temperatures, and testing for such properties as plasticity, green strength, dry strength, fired strength, shrinkage, and others. Our laboratory for cement industry service includes pilot plant apparatus for pulverizing cement clinker, fine grinding the cement at controlled temperatures, and specialized testing equipment for flow, air content, normal consistency, setting time, surface area, and other physical and chemical tests. For the resin field we have had to install very extensive facilities for both resin synthesis and end use of our resin grade products. For example, our equipment for preparing modified phenolic resins includes laboratory, pilot plant, and full commercial scale cooking kettles and auxiliary equipment. For study of the uses of our resins in plastic laminates we have set up a pilot plant resin treater for impregnating sheet stock, plus complete pressing and curing facilities for preparing decorative and industrial laminates. Plant scale equipment for mulling foundry sand with our resins is also available. Complete testing equipment has been provided to permit running the various tests normally performed in the manufacture of plastic laminates and

Forty-seventh
Annual Meeting
TAPPI

Hotel Commodore, New York, N. Y.
Feb. 18–22, 1962

NEW

Oakite booklet shows how to cut cleaning costs!

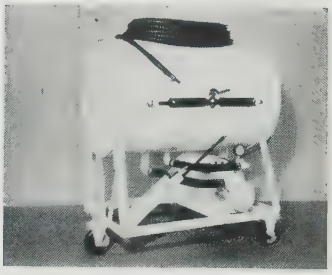


It's free... help yourself to dozens of cleaning tips on

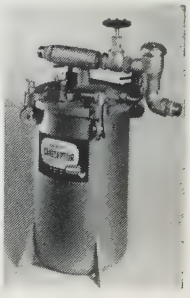
- **Pulp Washers, Pulp Screens**
- **Liquor Heaters**
- **Multiple Effect Evaporators**
- **Felts, Drying Rolls**
- **White Water Systems**
- **Suction Press and Couch Rolls**
- **Fourdrinier Wires**
- **Beaters • Jordans • Save-Alls**

...and head box, filter beds, pumps, dandy rolls, vats—just about every piece of equipment used in the pulp and paper industry requiring maintenance cleaning. Shows how to save time and money with Oakite materials, methods and mechanized cleaning equipment.

This new booklet was put together the hard way ...by condensing the Oakite know-how gained from years of working with pulp and paper mills. It's yours the easy way... simply by requesting a copy. Ask your local Oakite Technical Service Representative, or write to Oakite Products, Inc., 68 Rector Street, New York 6, N. Y.



OAKITE HOT-SPRAY UNIT gives you self-contained, mobile 'mechanized cleaning'. Spraying about 2 gallons of cleaning solution per minute, it covers 12,000 sq. ft. in half an hour. Excellent for cleaning papermaking machines, stock preparation units, walls, floors.



OAKITE SANISEPTOR is the simplest of mechanized cleaning units. Just fill with detergent and couple to any hot water outlet. Your water pressure works it—no pump, motor, coils or other equipment required. Portable to any point in the mill ... weighs only 25 lbs.

OAKITE "HURRICLEAN" steam-detergent gun is lightweight, cool handling, with swivel-action nozzle. Works off your plant steam supply. Does a marvelous job of power cleaning. Try handling one.

OAKITE

SCIENCE

over 50 Est. 1909 years' leadership in industrial cleaning

Export Division Cable Address: Oakite

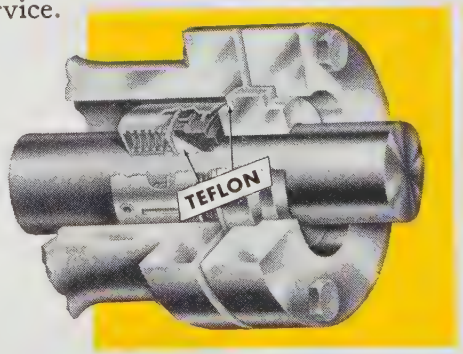
Technical Service Representatives in Principal Cities of U. S. and Canada

Performance records plainly prove that this "John Crane" development has successfully solved the handling of the most difficult corrosive liquids and gases. Where conventional type seals had failed, the Type 9 has done the job. It continues to answer new problems, including temperature conditions from —120°F. up to 500°F. . . . pressures to 150 psi. (to 750 psi. in balanced construction).

Designed to withstand practically all chemicals, the Type 9 incorporates a flexible wedge ring and sealing ring molded from DuPont's Teflon. It is engineered for the particular application and can be furnished in the metallurgical specification best suited to the service.

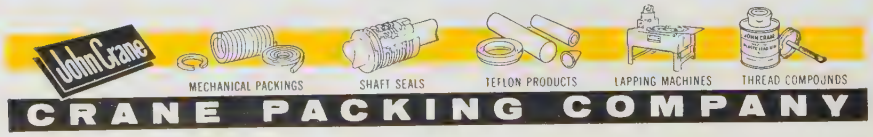
Use the Type 9 on all rotating shaft applications: centrifugal, rotary pumps, mixers, agitators, digester circulating pumps, other equipment.

Can be supplied in double seal construction where required.



Get complete information on the Type 9 Seal from Crane Packing Co., 6488 Oakton St., Morton Grove, Illinois, (Chicago Suburb).
In Canada: *Crane Packing Company, Hamilton, Ont.*

**DuPont trademark*

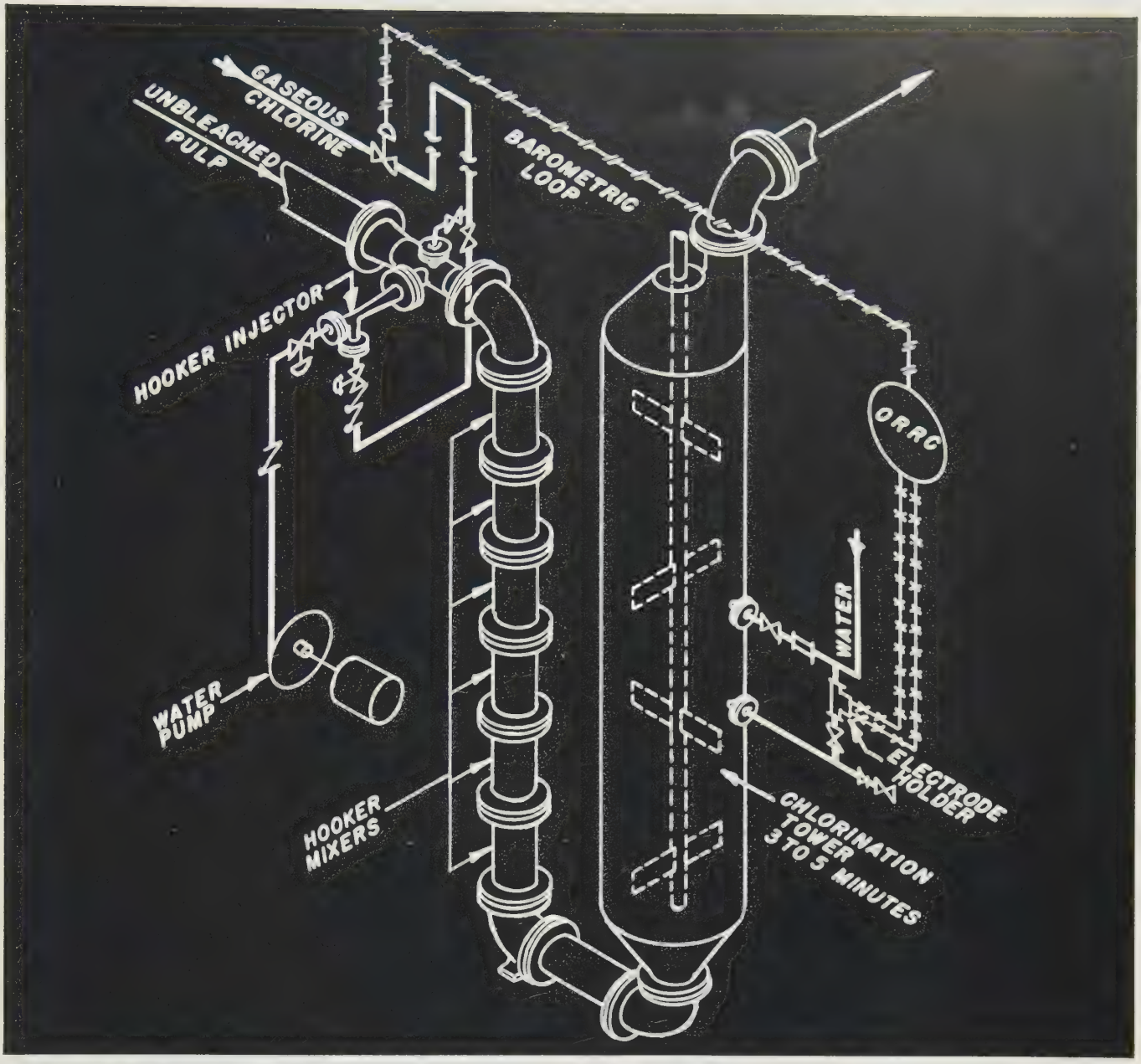


foundry resins. Finally, for the study of the use of our products in rubber, we had to install laboratory, pilot plant, and semicommercial equipment for preparing so-called rubber masterbatches, which involves the combination of our products with rubber beginning with rubber latex and going through the normal rubber plant operations of precipitation, coagulation, filtration, washing, and drying. Also required was a complete rubber compounding and testing laboratory equipped to mill rubber or rubber masterbatch samples with compounding and curing chemicals, mold and cure test specimens, and conduct the usual rubber tests including tensile strength, modulus, abrasion resistance, tear resistance, hardness, resilience, and others.

Other applications which have been developed for our products include emulsion stabilization, dye dispersion, insecticide dispersion, boiler water treatment, storage batteries, and fire foam stabilization. These uses for the most part are low in tonnage potential in that they depend on the surface active properties of our products when applied in low concentration. They also require technical service, although not in proportion to the outlets previously described.

In summary it can be said that, based on our company's experience, there is certainly no easy road to the successful commercial development of products from lignin-derived raw materials. It requires the careful selection and definition of a uniform raw material source, an intensive study of the structural chemistry of the raw material and its derivatives, the development of accurate process controls, and thorough familiarization with the technologies of the end uses to permit the provision of adequate technical service.

Presented at the Lignin Symposium sponsored by the Technical Association of the Pulp and Paper Industry, held in Chicago, Ill., Aug. 14–16, 1961.



New package whips the variables in pulp chlorination

The first requirement for uniform pulp quality, high pulp strength and high brightness is optimum pulp chlorination—exactly the correct amount of chlorine for each pulp fiber.

Optimum chlorination is accomplished by three steps—each interdependent and equally important:

1. Rapid solution of gaseous chlorine in the pulp slurry—the Hooker chlorine injector is designed specifically for this. Maximum use is made of water energy to atomize the chlorine for rapid, uniform solution in the pulp slurry.

2. Uniform distribution of chlorine solution around each pulp fiber—Hooker stock line chlorine-pulp mixers break up the fiber clumps and distribute the chlorine solution uniformly throughout the pulp slurry. An agitated reactor holding the stock an additional 3 to 5 minutes supplements the stock line mixers. Efficient and continuous mixing is assured throughout the first few critical minutes of the reaction. Each fiber receives the same amount of chlorine.

3. Automatic control of chlorine addition by redox potential—ends the guesswork in chlorine application, reducing chlorine consumption and improving pulp quality. Successful redox control requires efficient chlorine injection and thorough chlorine-pulp mixing.

Hooker technical service engineers will help you design and install the Hooker chlorine injection system, Hooker stock line chlorine-pulp mixers and supplementary reactor, and the redox control system . . . For the full story, write for Bulletin 258: "Improved Pulp Chlorination."

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

2111 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y. • 605 ALEXANDER AVE., TACOMA, WASH.

Sales offices: Buffalo, Chicago, Detroit, Los Angeles, New York, Niagara Falls, Philadelphia, Tacoma, Worcester, Mass. *In Canada:* Hooker Chemicals Limited, North Vancouver, B. C.

WHICH OF THESE WAX ENDURANCE TESTS WOULD BE MOST HELPFUL TO YOU RIGHT NOW?

In the course of a year, probably all the rugged performance tests shown here could be of some value to you. However, at least one should prove useful in resolving some immediate coating problem. You may, for example, require a wax with a high degree of resistance to oils and greases; or flexibility may be the prime consideration. Quite often, the precise degree to which these characteristics must be present to meet your customer's specifications can best be established by proved laboratory testing methods.

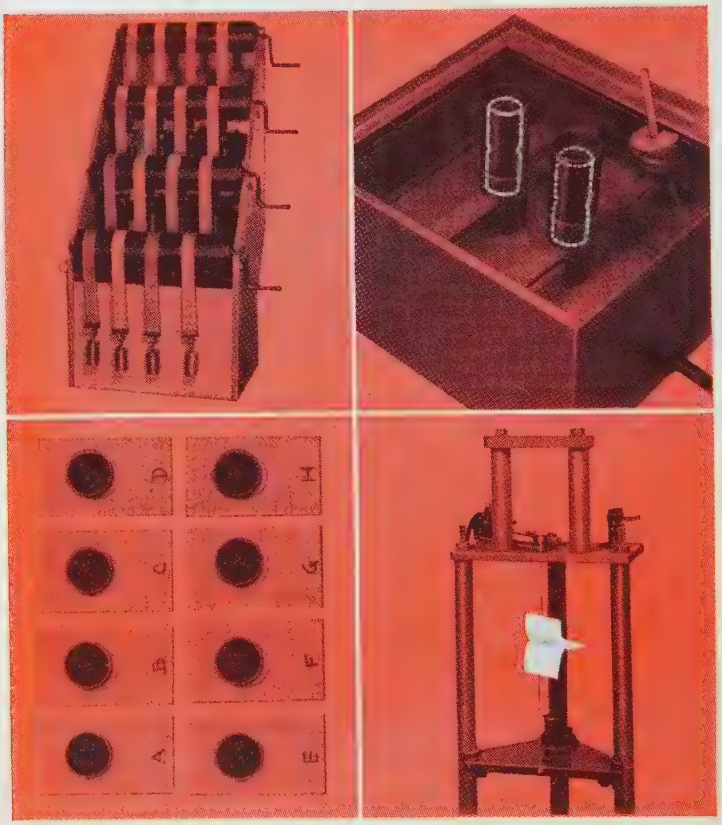
Whatever your paraffin requirements may be, there's almost certainly a practical test for determining the proper wax or waxes to do the job. Your Atlantic Sales Engineer will be happy to give you full information on how our research facilities can be of service to you. In most cases, he can supply on-the-spot assistance based on years of experience in the field. When more specialized information is required, he has the full and prompt assistance of the Atlantic Research Department.

THE FLEX-CRACKING TEST

A new testing device to determine proper wax coatings for low temperature operations. Strips of heavily waxed paper are flexed over standard dowels to measure resistance to cracking at various temperatures. The correct coating will remain flexible under these extreme conditions.

GREASE RESISTANCE TEST

This technique is of particular value to packers of products with high animal or vegetable oil content. The wax-coated stock is placed on a blotter and an oil containing a dye is floated on the surface. Performance is determined by strike-through time and degree of penetration.



UNDERWATER BEAM TEST

The purpose of this test is to establish the durability of waxed corrugated board under load when totally submerged in water. Standard of measurement is the time required to collapse under measured weight and water temperature. The Beam Test can be applied to all grades of waxed corrugated board by varying the test conditions.

SEAL STRENGTH TEST

To establish the adhesive properties of wax seals, the seals are separated by pulling the parts evenly in opposite directions. This Seal Strength Test is of particular importance to processors of bread wraps and other products where wax is the only adhesive.

CHOOSE FROM OUR FULL LINE OF HIGH-QUALITY WAXES TO MEET YOUR COATING NEEDS

Philadelphia, Pa.
Providence, R. I. • Syracuse, N. Y.
Pittsburgh, Pa. • Charlotte, N. C.

ATLANTIC

THE ATLANTIC REFINING COMPANY

what features
and advantages
does the new

BELOIT CALENDER

design bring
to papermaking?

for answer, please turn page

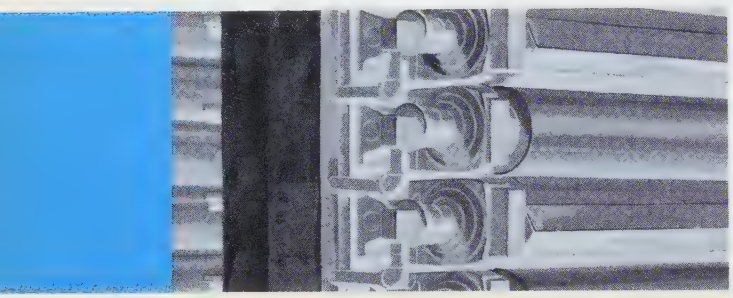
BELOIT CALENDERS

...new concept provides more efficient and economical operation

The new Beloit Calender shown here represents a major breakthrough in calender design and gives promise of greatly increased operating efficiency. Every feature of this new-type machine calender reflects rugged dependability, operator convenience, and ease of operation. Location of roll-lift mechanism in the base eliminates the necessity for service ladders and footwalks, and substantially lowers the over-all calender height. Other important features:

- rapid, positive roll removal
- direct air-cushioned loading and nip relieving
- rolls individually supported in raised position
- operating ease and accessibility.

Descriptive literature upon request.



BELOIT

PAPER MACHINERY

your partner in papermaking

SCAPA Research
Sets the Pace!

Scapa's Instron Machine is not used exclusively for the routine testing of fibers, yarns and felts. It plays an important part in Scapa's never-ending Research activity.

R2

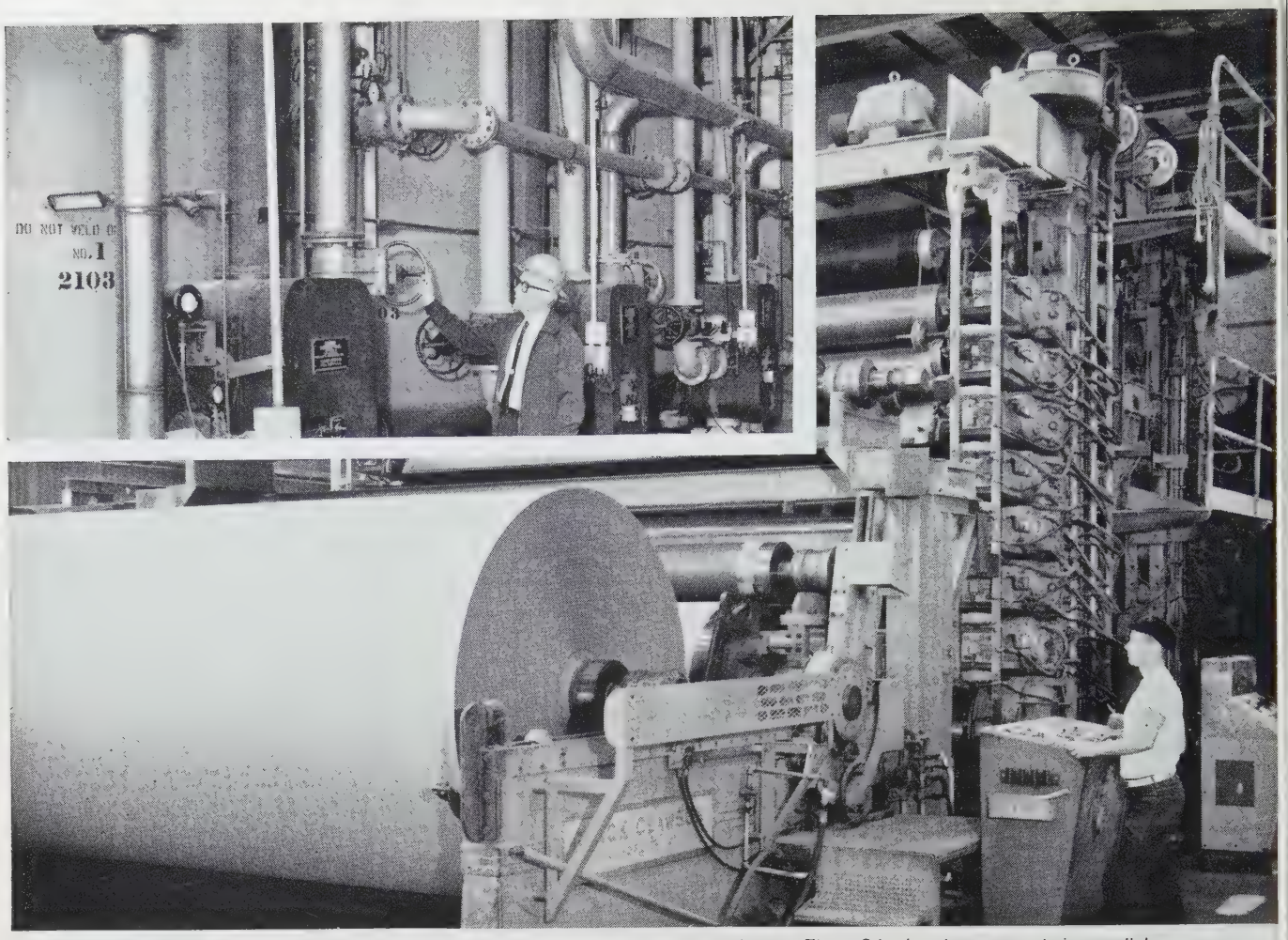
SCAPA DRYERS, INC. WAYCROSS GEORGIA

SELLING AGENTS

Morey Paper Mill Supply Company
309 SOUTH STREET, FITCHBURG, MASS.

John B. Chandler Co.
P. O. BOX 1748, ATLANTIC BEACH, FLA.

Tipka Supply Company
415 JACKSON ST., OREGON CITY, ORE.



INSET: Ion exchange units at Longview Fibre Company, Longview, Washington. Three 2-bed systems operate in parallel.

AMBERLITE® ion exchange resins still effective at Longview Fibre after treating 2,000,000,000 gallons of river water

Deionizing boiler makeup water for power generation at Longview Fibre Company, Longview, Washington, makes heavy demands on ion exchange resins. Raw water from Columbia River has high silica content (as much as 19 ppm SiO_2) and contains some organic material. Clarification requires heating, and water enters ion exchange beds at an elevated temperature of 95°-100°F.

Serving under these conditions, AMBERLITE IR-120 cation exchange resin and AMBERLITE IRA-400 anion exchanger operating in three 2-bed units have treated a combined grand total of over two billion gallons of water to date. Each cubic foot of anion exchange resin in two of these 2-bed units, installed in 1954, has treated over 4,300,000 gallons of water. (Third unit was installed in 1957.) Treated water has 750,000 ohms specific resistivity and only 0.03-0.05 ppm silica content.

The service AMBERLITE resins provide for Longview Fibre is typical of AMBERLITE performance in uses ranging from boiler water treatment to chemical processing. A broad selection of Rohm & Haas ion exchange resins lets you pick the right resin for any application. Write for technical literature and information.

Booklet available free, shows how AMBERLITE ion exchange resins are used in many industries. Address your request to Dept. IE-7.

ROHM & HAAS

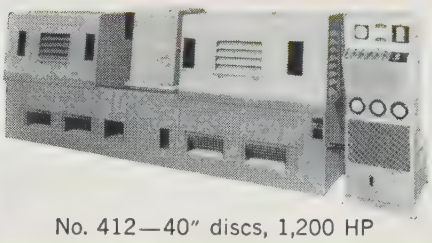
PHILADELPHIA 5, PA.

AMBERLITE

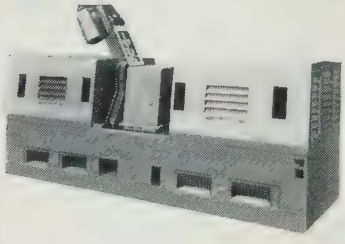
No. 480—48″ discs, 3,000 HP.
World's largest field proven pulp refiner.

NEW FOR '62!

No. 414—44″ discs
2,000 HP



No. 412—40″ discs, 1,200 HP
(shown without feeder)



No. 401—36″ discs, 600 HP
(shown without control unit)

Bauer

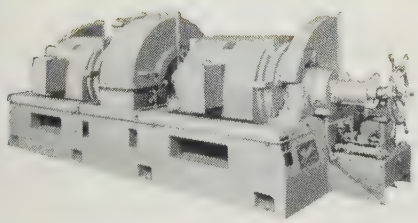
Double Revolving Disc Refiners...*In the size you want!*

With four brand new models of the field proven 480 type now added to the lineup, Bauer offers the most complete selection of double revolving disc refiners to help solve your particular pulp preparation problem. Machines are available with power ratings from 200 HP to 3,000 HP, with disc sizes from 24″ to 48″. The unique double revolving disc action of these refiners preserves, rather than shortens, fiber length, thus developing fiber strength and pliability. These refiners are widely used for groundwood, kraft and sulphite screenings; semi-chemical pulp; Bauerite pulps; sulphite pulp and paper refining (for tissues, etc.); straw, bagasse; high yield sulphite; waste paper and de-ink; and bleaching.

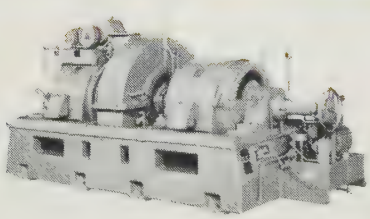
Ask for the new descriptive bulletin.

THE BAUER BROS. CO., Springfield, Ohio

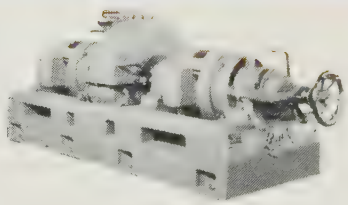
In Canada: The Bauer Bros. Co. (Canada) Ltd., Brantford, Ontario



No. 411—40″ discs, 800 HP



No. 400—36″ discs, 400 HP



No. 415—24″ discs, 200 HP

Let Du Pont help you get the right opacity at the right price

When you buy white pigments, you're buying opacity. But if your choice of pigments gives more opacity than you need or opacity at a sacrifice of brightness and strength—you're wasting money!

And here is where your Du Pont Pigments Representative can help you. He can draw upon the widest choice of pigments available to give you just the opacity you require, while maintaining all other desirable properties. Du Pont's broad line of "Ti-Pure" titanium dioxide pigments includes many new grades not available elsewhere—grades that were developed especially for the paper industry.

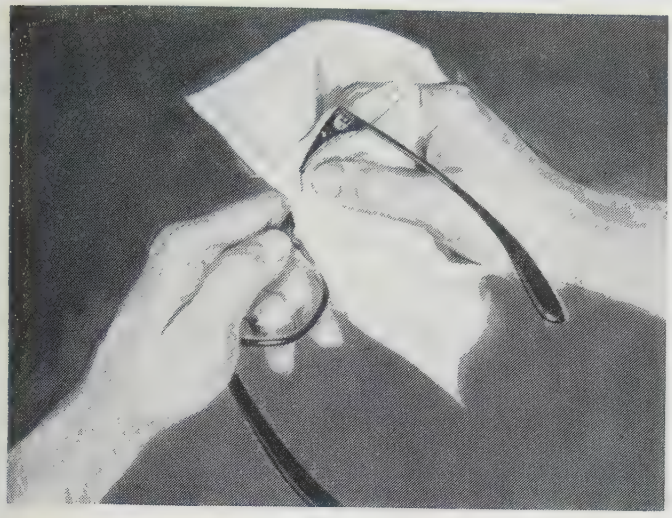
Call your Du Pont Pigments Representative. He'll prove to you the important thing is not what you pay for the pigment—it's what you pay for opacity.

Du Pont, Pigments Dept., Room D-2060, Wilmington 98, Delaware
In Canada: Du Pont of Canada, Ltd., P.O. Box 660, Montreal, Quebec

DU PONT REG. U. S. PAT. OFF. **TI-PURE®** titanium dioxide pigments

BETTER THINGS FOR BETTER LIVING...THROUGH CHEMISTRY

An example of Avisco Rayons in Industry



It's easy to make non-wovens on your present wet system with Avisco® rayons

Avisco rayon fibers are ideal for making non-wovens on your existing wet system because fiber lengths, diameters and physical properties can be precisely controlled. You get all the economy of high-speed wet system operation plus the tremendous versatility of rayon.

Non-wovens of Avisco rayon can be made lustrous or dull, strong, flexible, drapable. Consider these fibers for napkins, table cloths, wiping cloths, filters, hospital sheets and pillow cases, disposable garments of all types, draperies and other applications both industrial and domestic.

Write for information on rayon in non-wovens, produced on the wet system. Send in the Quick Reply Coupon at right.

QUICK REPLY COUPON 8-7

Industrial Merchandising Division
American Viscose Corporation
350 Fifth Avenue, New York 1, N.Y.

Please contact me about Avisco Rayons for use in the following application:_____

Name_____

Company_____

Address_____

City_____ Zone____ State____

AVISCO® RAYON

AMERICAN VISCOSE CORPORATION, 350 Fifth Avenue, New York 1, N. Y.

Why have so many installations of chemical recovery units (in the past five years) been equipped with Bailey instruments and controls?

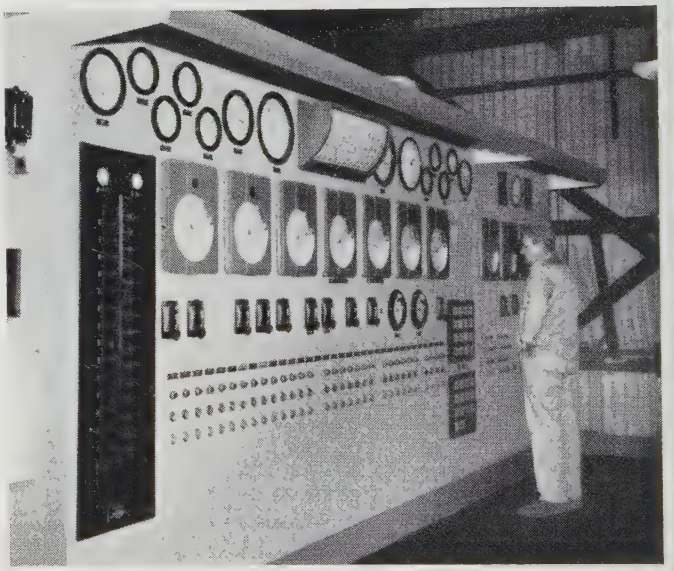
Bailey assures reliable and continuous operation with a control system engineered specifically for the chemical recovery process.

Every Bailey installation gives top performance. It's the reason for Bailey's long and prominent association with chemical recovery . . . and it's why you'll find Bailey instruments controlling virtually every process within many pulp and paper mills.

Bailey starts with sound engineering and economic evaluation of your needs . . . an evaluation based on more than 40 years' experience, kept fresh by a national network of engineers in constant contact with your industry.

Then the selection of the *right* system . . . selection made simple by a complete line of equipment . . . from conventional instruments through sophisticated data processing systems.

That's the Bailey way. Put this logic, capability and performance to work on any process control problem you have. Call on the Bailey District Office or your nearby Resident Engineer. Or, write direct.



In Oregon—maximum economy, minimum maintenance since 1958; Bailey control center for chemical recovery unit at Georgia-Pacific Paper Co., Toledo, Oregon. Evaporator system (right) is also operated from this Bailey center.

P152-1

PULP AND PAPER DIVISION

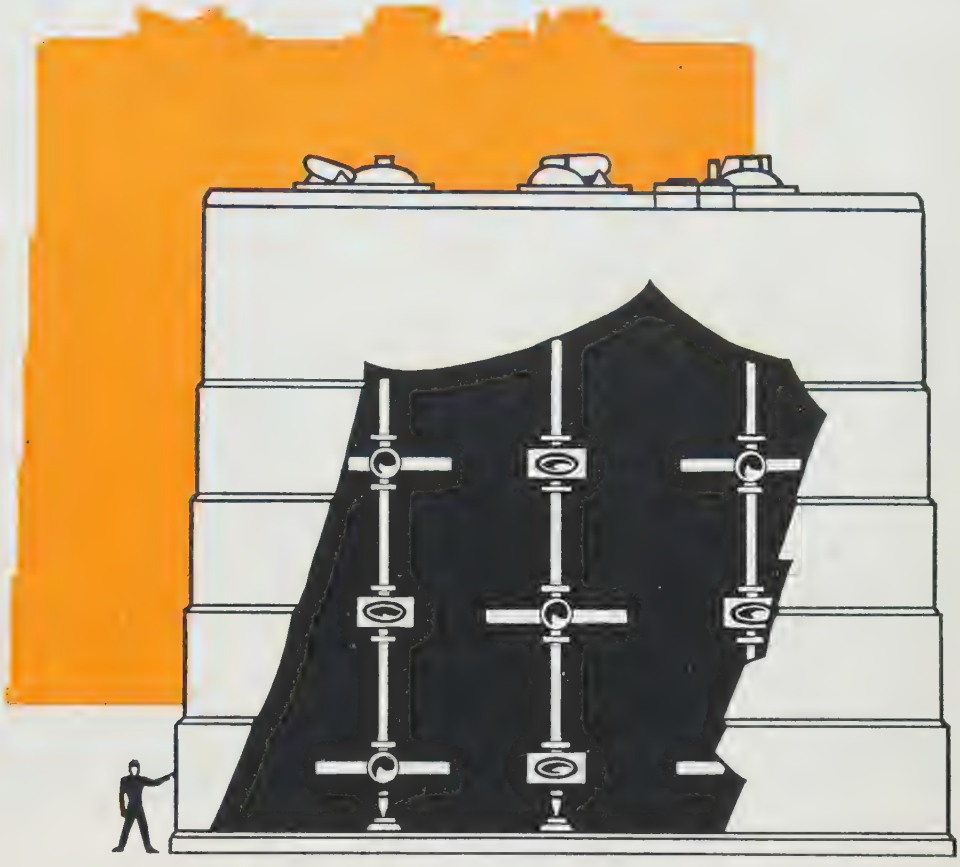
BAILEY METER COMPANY

1077 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

The storage tank, source of stock uniformity



Better blending means improved paper production and quality. Volume of output at the desired paper quality depends in practice on the volume of blended storage. Tank capacity must therefore be adequate yet consistent with thorough agitation at economical power.

Replacing blades and paddles with the Cowan agitator — in effect a high-volume low-head pump — has permitted measurable full blending with low power consumption. Cowan-designed agitation units are at work in storage tanks of extremely large diameter. Their success demonstrates that thorough blending of tank content at moderate power is fully compatible with large storage capacity.

Agitation in large-diameter tanks is something we look forward to discussing with you. We will act promptly on your letter, phone call or wire.

S.W. HOOPER CORPORATION

Manufacturers of pulp and paper mill equipment
P.O. Box 129, Delmar, N.Y. Telephone HEmlock 9-5231

In Canada: S. W. HOOPER & CO. LTD. 5460 Patricia Avenue, Montreal 29. Telephone HUnter 1-1161

Getting the results you want from agitated chests and tanks is the subject of this new 112-page manual.

Complete, factual, informative, it is the first book of its kind ever written for pulp and paper engineers. It is based on ten years of unique research into the technology of mixing and agitation in the pulp and paper industry, and on hundreds of mill installations, many of which it describes and illustrates.

Anyone in the industry whose work involves agitation or mixing can get a copy free and without obligation by writing to us on his company letterhead.

Here is a partial list of the contents

PAPER STOCK AGITATION. Defining process results, complete uniformity in stock chests, complete motion, controlled zone agitation, side-entering agitators, stock consistency and power requirement, impeller selection, consistency control in continuous systems, performance and design of paper stock mixers.

Case examples. Machine chests, storage chests, blending and mixing chests, mixing boxes.

High-density storage, bleaching, blow pits and blow tanks, couch pits, repulpers.

PULPING LIQUORS. Fluid dynamics: blending, heat transfer, solids suspension, dissolving, gas-liquid operations, liquid-liquid contacting.

Case examples. Green liquor storage, salt cake dissolving, bleach liquors, lime storage, bleach liquor storage, smelt dissolvers, sulfur melters, waste neutralization and oxidation.

COATING SYSTEMS. Clay makeup, clay storage, starch cooking and storage, coating storage, dye solution tank, coating blender.

EQUIPMENT DESIGN. Basic design factors, basic mixer components, materials of construction, vertical installations, horizontal installations.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 142-m Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 19, Ont.

In Europe: Lightnin Mixers, Ltd., Poynton, Cheshire, England

For maximum quality...
Rex bleaches with Solvay Hydrogen Peroxide

This sheet is Rex Glo Dull. It is one of the quality coated offset stocks produced by the Rex Paper Co. for high-caliber advertising printing and annual reports.

Rex starts with a composite stock containing a high percentage of reclaimed paper. Solvay® Hydrogen Peroxide, used in the bleach liquor, helps them produce high grade conversion coated offset paper. They report hydrogen peroxide provides maximum brightness without the fiber degradation of harsher bleaching agents.

Solvay technical representatives will be glad to work with you on improving brightness and reducing bleaching costs. Contact your nearest Solvay branch office . . . no obligation, of course.

SOLVAY CHEMICALS FOR THE PAPER INDUSTRY
Caustic Soda • Chlorine • Hydrogen Peroxide • Soda Ash

Allied Chemical

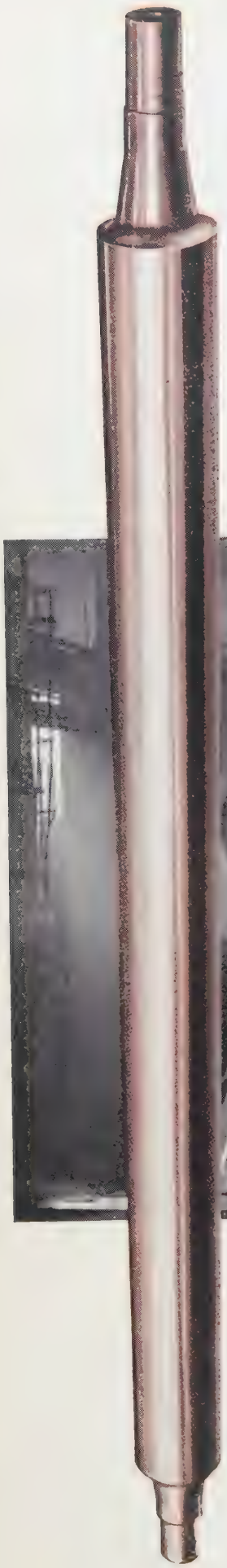
SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N.Y.

UNITED

CHILLED IRON AND
ALLOY CHILLED IRON

ROLLS

FOR PAPER AND ALLIED INDUSTRIES



- CHILLED IRON ROLLS
- MACHINE CALENDER STACKS
- ROLL GRINDING MACHINES
- ROLL CALIPERS
- KNIFE GRINDERS

UNITED FURNISHES THE LONGEST AND HEAVIEST ROLLS required by the paper industry. United Chilled Iron Rolls for machine calendering give longer service; are uniformly hard and highly resistant to abrasion and deformation. For water finish or high pressure stocks, United rolls of special alloys are available.

1901 U.E.&F.CO. 1961

Progress... Leadership United for Sixty Years

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH 22, PENNSYLVANIA

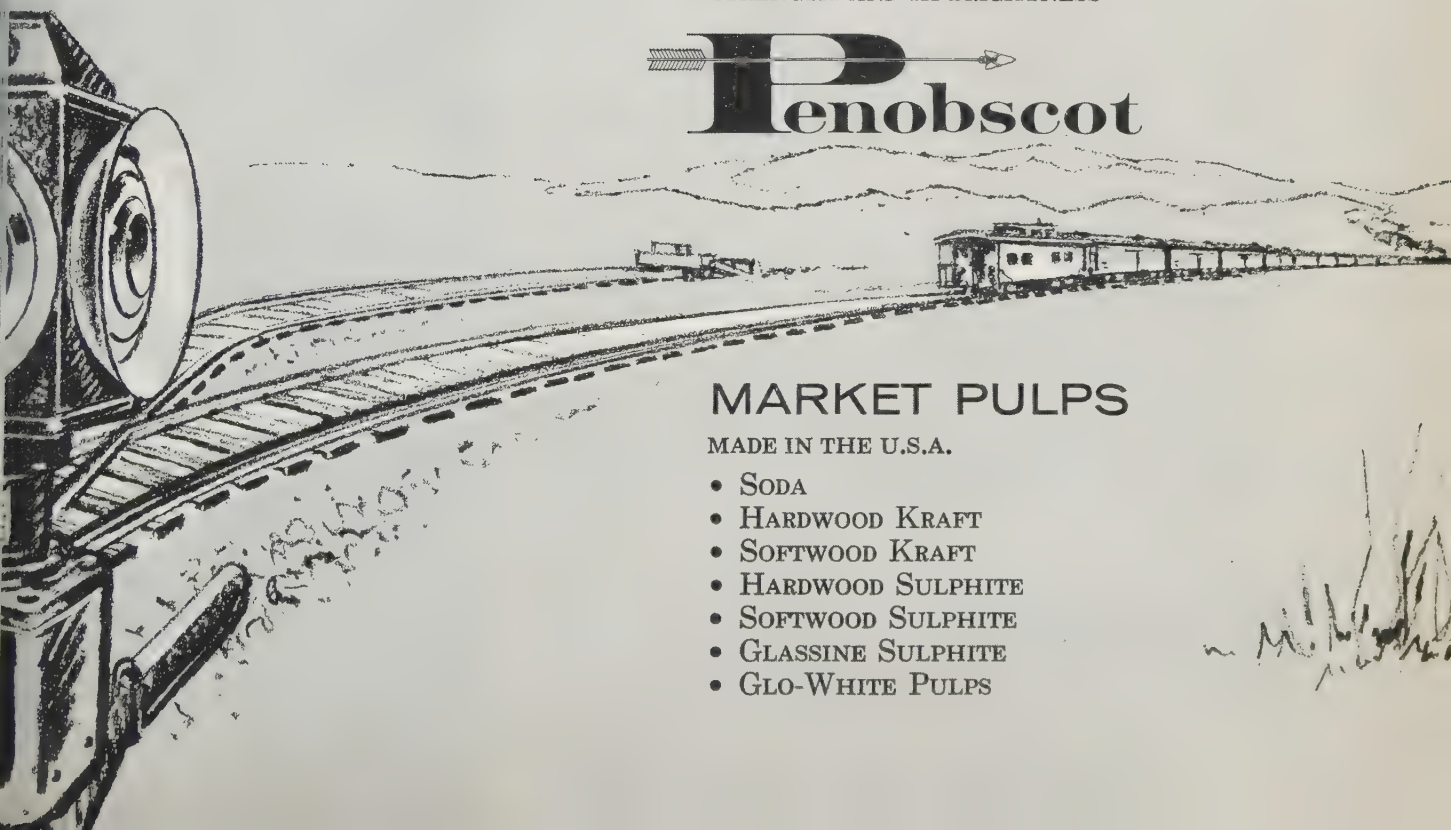
You always have priority on Penobscot Market Pulps

Your order for Penobscot Pulp is never sidetracked for an intra-company "special". Through the business cycles of the past 70 years, supplying independent paper mills has been Penobscot's most important business. Our new Kraft Mill further increases Penobscot's ability to fill your requirements for all bleached paper grades of pulp. We invite correspondence with mills seeking a dependable source of domestic pulps for the *long haul.*

PENOBSCOT CHEMICAL FIBRE CO. Mills: Great Works, Maine. Sales Office: 211 Congress St., Boston 10, Mass. — LI 2-3870

CHLORINE DIOXIDE BLEACHED FOR STRENGTH AND HI-BRIGHTNESS

Penobscot



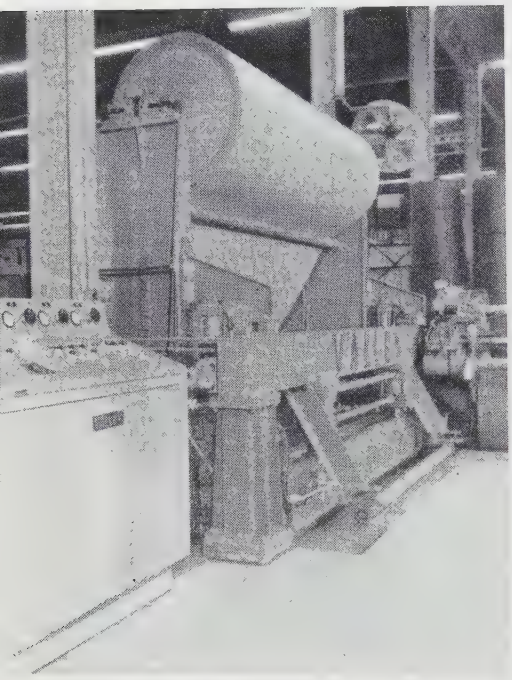
MARKET PULPS

MADE IN THE U.S.A.

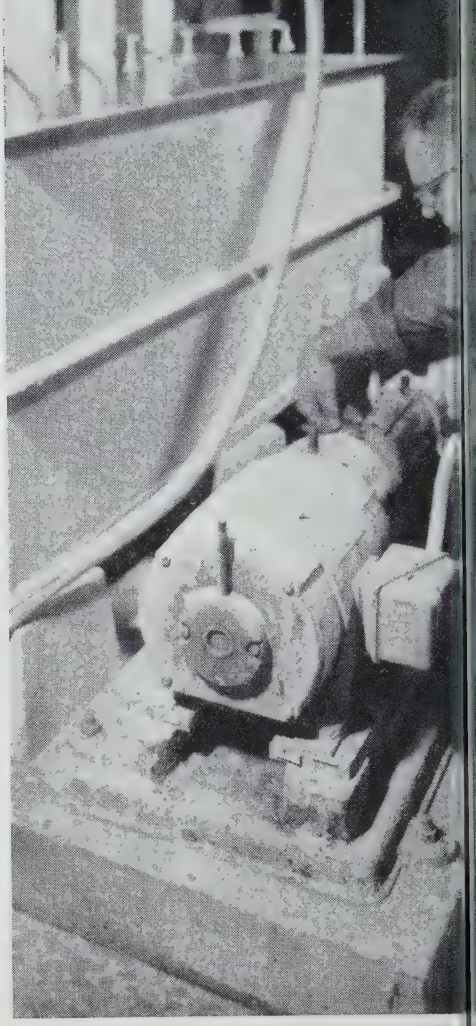
- Soda
- Hardwood Kraft
- Softwood Kraft
- Hardwood Sulphite
- Softwood Sulphite
- Glassine Sulphite
- Glo-White Pulps

ideas and news

Open motor shrugs off everything but work: This 5-hp SUPER-SEAL motor performs with unfailing dependability . . . even though it's usually covered with a foamy pulp mixture. Two or three times a day, it gets cleaned — with a hose. POXEAL insulation makes it impervious to moisture, dust, and most contaminants . . . enabled this open motor to replace a totally-enclosed, fan-cooled unit that had to be frequently rewound.



New "pushbutton" system wraps a roll-a-minute: An Allis-Chalmers subsidiary, Valley Iron Works Corporation, has developed an automatic system that can wrap more than 60 rolls an hour. The new system eliminates the need for expensive trimming machines, glue pots and inconveniences common to ordinary wrapping methods. Valley's console-controlled machine cuts the wrapping paper to proper size without manual settings, wraps the roll and crimps the ends for application of headers. Equipment can be varied to use inner or outer heads, or a combination of the two. The system is capable of wrapping rolls of varying sizes in succession. It can handle rolls of face lengths from 7 to 112 inches, diameters from 15 to 42 inches—other sizes are available. Valley is a major supplier of papermaking machinery and auxiliary equipment.



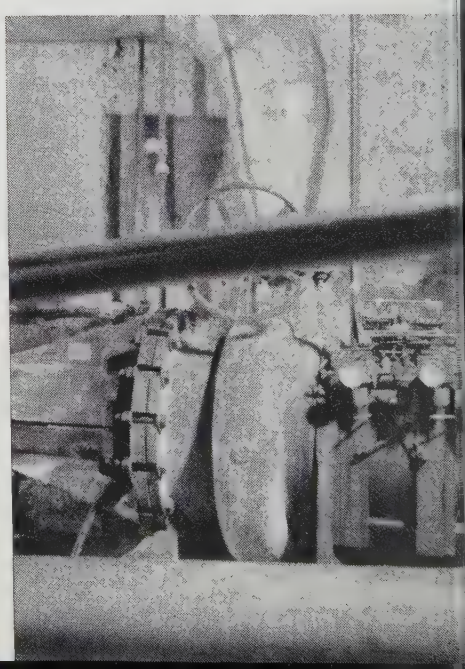
ACAP pump regulates flow automatically... and does it without restricting flow or varying pump speed. Proven ACAP (Adjustable Capacity, Adjustable Pressure) principle with internal pneumatic control automatically matches flow to demand. Flow is regulated through changing impeller clearances to eliminate binding, plugging...save power . . . allow the system to operate at high efficiency regardless of demand.

Which one of these productive ideas could be working for you?

An open motor that shrugs off a soaking. A "pushbutton" roll-wrapping system. A pump that adjusts automatically. These examples demonstrate the extra value that is a standard with A-C . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, 903 South 70th Street, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS PRODUCTS FOR THE PAPER INDUSTRY: Look to Allis-Chalmers for compressors; controls; earth-moving equipment; industrial systems; lift trucks; motors; papermaking machinery; pumps; rectifiers; electrical generation and distribution equipment; tractors; transformers; unit substations; valves; water-conditioning equipment. A-1545

Super-Seal, Poxeal and ACAP are Allis-Chalmers trademarks.



ALLIS-CHALMERS

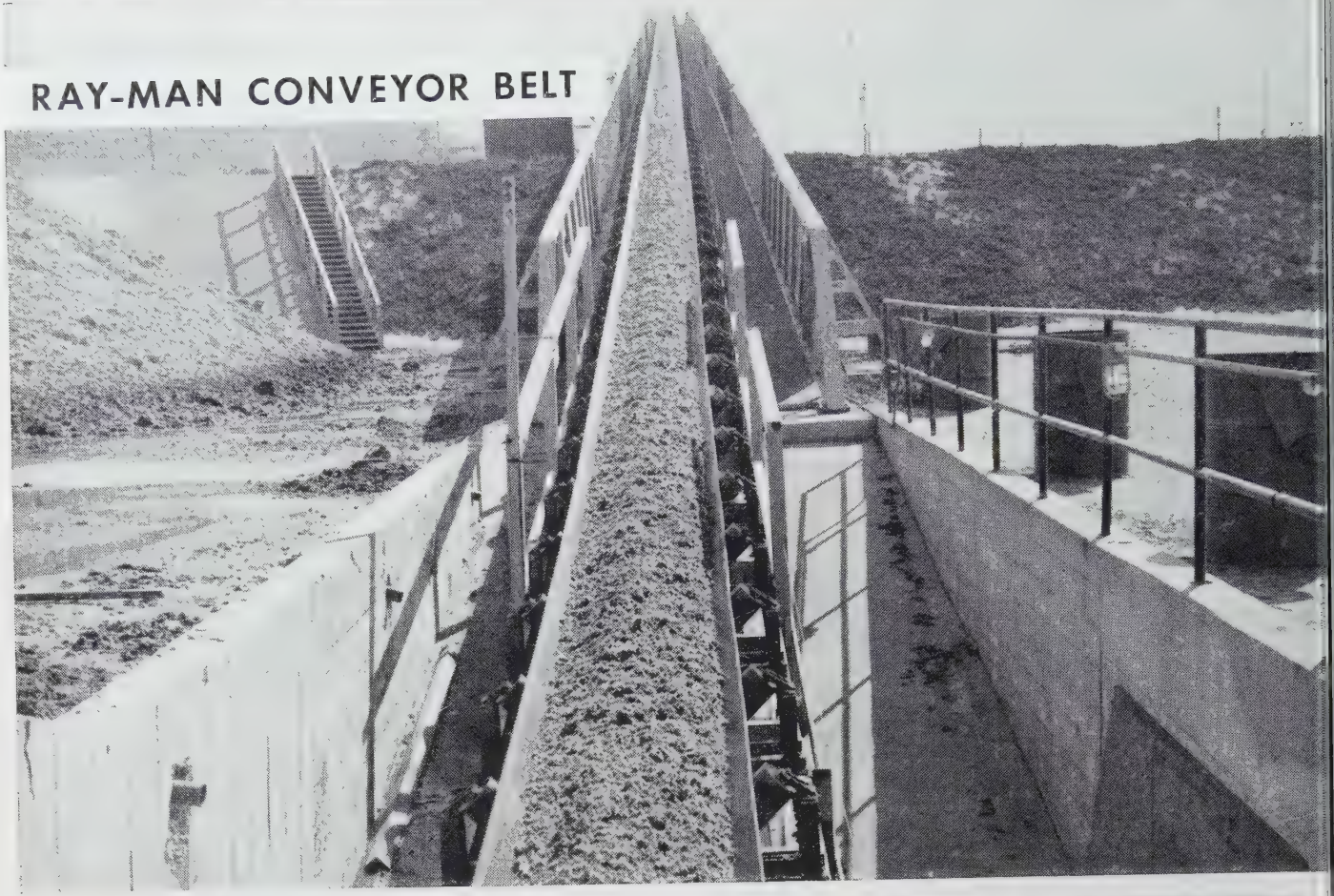
Marmix®

RESIN & RUBBER LATICES

Here, to meet your needs for resin and rubber latices, is Marbon Chemical's new multi-million dollar research and production facility on the Ohio River. In every way—plant facilities, equipment and personnel—you'll find Marbon the truly modern source for your requirements. Let us prove it—write today, Dept. Y-11.

MARBON CHEMICAL DIVISION **BORG-WARNER**
WASHINGTON WEST VIRGINIA

RAY-MAN CONVEYOR BELT

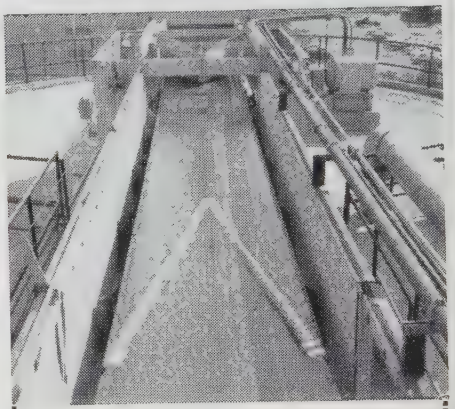


RAY-MAN Troughs Deeper, Trains Easily ...For Highest Pulp and Chip Capacity

Ray-Man conveyor belt and 45° idlers provide pulp load capacity at this Crown-Zellerbach Pacific coast paper mill. Consider these advantages of Ray-Man for your conveyors:

- **High Cover-adhesion All Around**—top, bottom, and edges
- **Full Cover Thickness Used**—no breaker needed, longer cover life
- **Splices Last Longer**—holds fasteners better
- **More Troughable and Trainable**—highly flexible, double Compensated
- **Designed for 45° Idlers**—guaranteed against separation at idler hinge line
- **Operates on Smaller Pulleys**
- **Impact Cushioned**—resists ripping

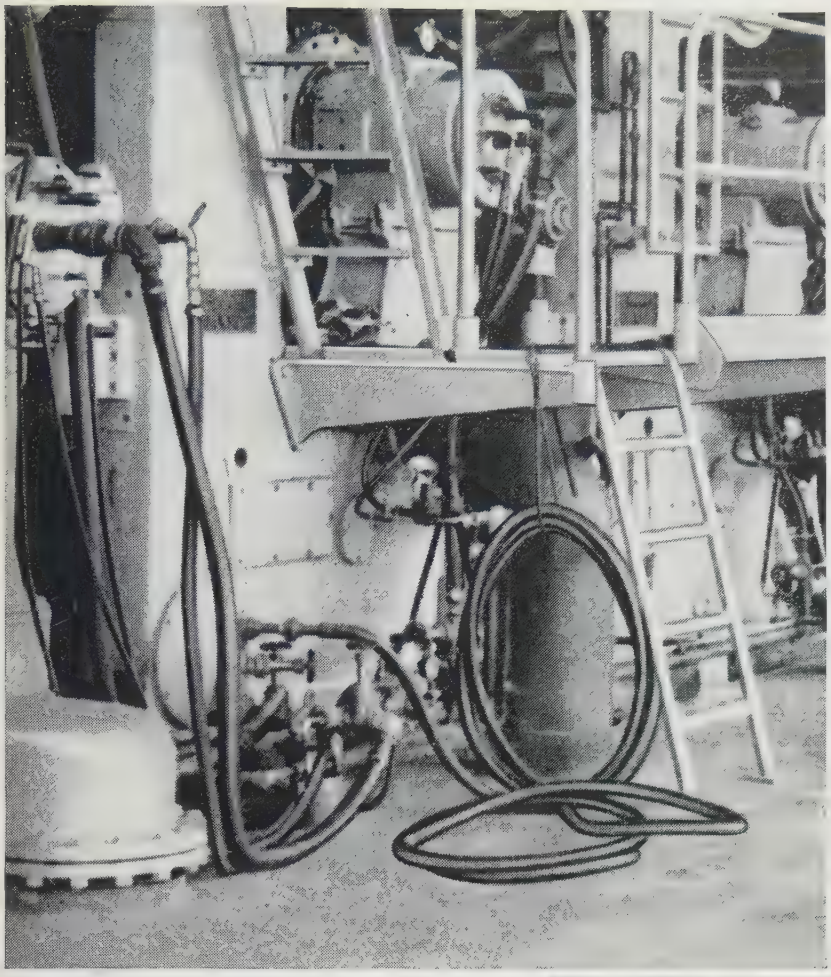
Ray-Man is mildew-proof and moisture resistant . . . can be made oilproof for use with chippers. Ask your R/M distributor about Ray-Man or about log conveyors. Write for Bulletin M303.



R/M'S PATENTED WEDLOK SPLICE Provides Dependable, High-Tension Mechanical Splice with a Vulcanized Splice-Rating on Ray-Man Conveyor Belts at Crown-Zellerbach. Get "More Use per Dollar" . . . Save Time and Money with Wedlok Splice. Write for Bulletin M380.

RM-108

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS



HOMOFLEX Paper Mill Hose Is Light . . . and Flexible as a Rope

Homoflex is the easiest handling wash-down hose made and weighs less than any other hose for equal working pressure.

- **Super-Strong** — assures longer, trouble-free service life
- **Precision Built**—Homogeneous construction provides inseparable tube-to-cover bond
- **Kinkless**—coils and uncoils freely in any direction
- **Mandrel-Made**—no pre-set twist
- **Safer, Easier Coupling** — inside and outside diameters are uniform
- **Available With Built-In Tapered Rubber Nozzle**—prevents machine damage

Write for Catalog M5.

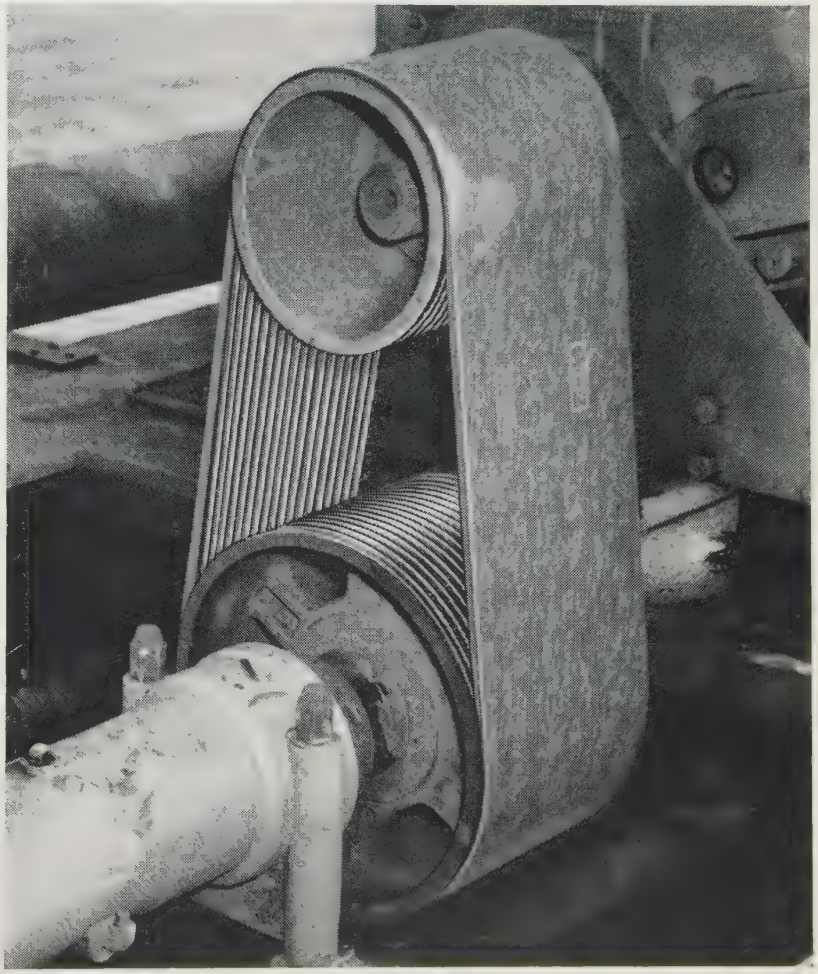
R/M POLY-V® Drive Delivers More Power in Less Space . . . with More Reliability

A single, endless V-ribbed belt across full width of sheaves with mating grooves. Gives more power per inch of width and advantages never possible with conventional multiple belt drives.

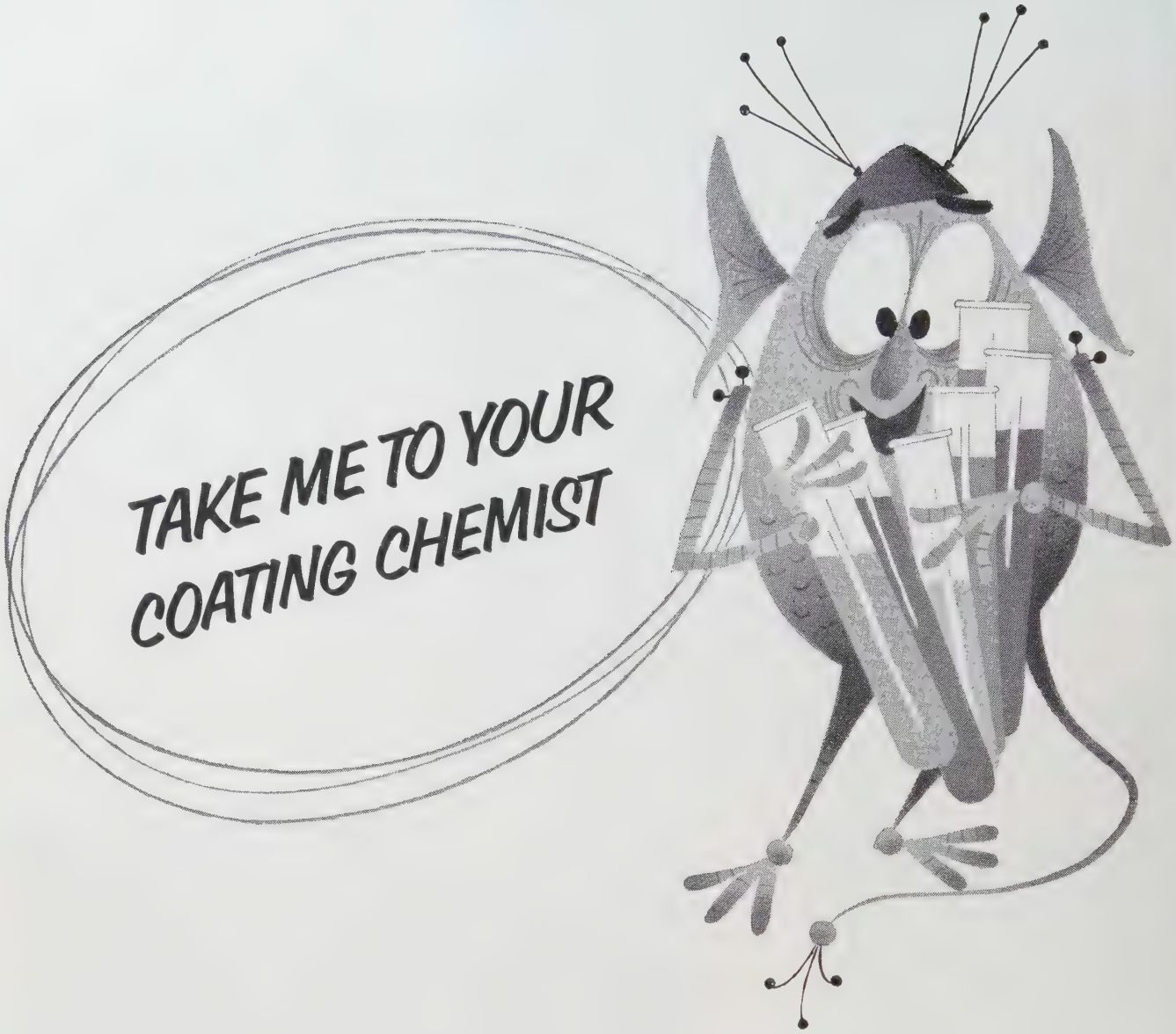
- **Simplicity**—*two* belt cross sections meet *every* heavy duty requirement
- **Reliability**—less maintenance, less take-ups . . . longer belt and sheave life
- **No Matching**—single unit belt eliminates "length matching"
- **Better Performance** — maintains groove shape, constant pitch and speed ratios . . . runs smoother, cooler

WHEN YOU CHANGE DRIVES CONVERT TO POLY-V* . . . AND BE SURE.
Write for Bulletin M141.

*patented



A SKILLED HAND IN CHEMISTRY . . . AT WORK FOR YOU



Nopcote® C-104 is out of this world when it comes to lubricating protein, starch or latex coating colors. A fluid-stable, 50% calcium stearate dispersion, it produces a clean, dust-free coating with improved gloss—even at low calender pressures.

This lubricant improves flow and leveling characteristics to the point where a smooth, even application is possible at high speeds and on any equipment—trailing blade, roll train, air knife, or size press. It minimizes surface pattern, too, and gives your sheet that extra increment of salability.

This mill-proven coating additive is fluid and easy to handle. Other advantages are that it has little effect on color viscosity and permits application of high-solids, quick-drying coatings.

Nopco technical representatives will be happy to supply samples of Nopcote C-104 and set up a mill trial at your convenience.

Dispersants
Defoamers
Wax Sizes
Calender Stack Lubricants
Detergents
Emulsifiers

NOPCO CHEMICAL COMPANY

NOPCO®

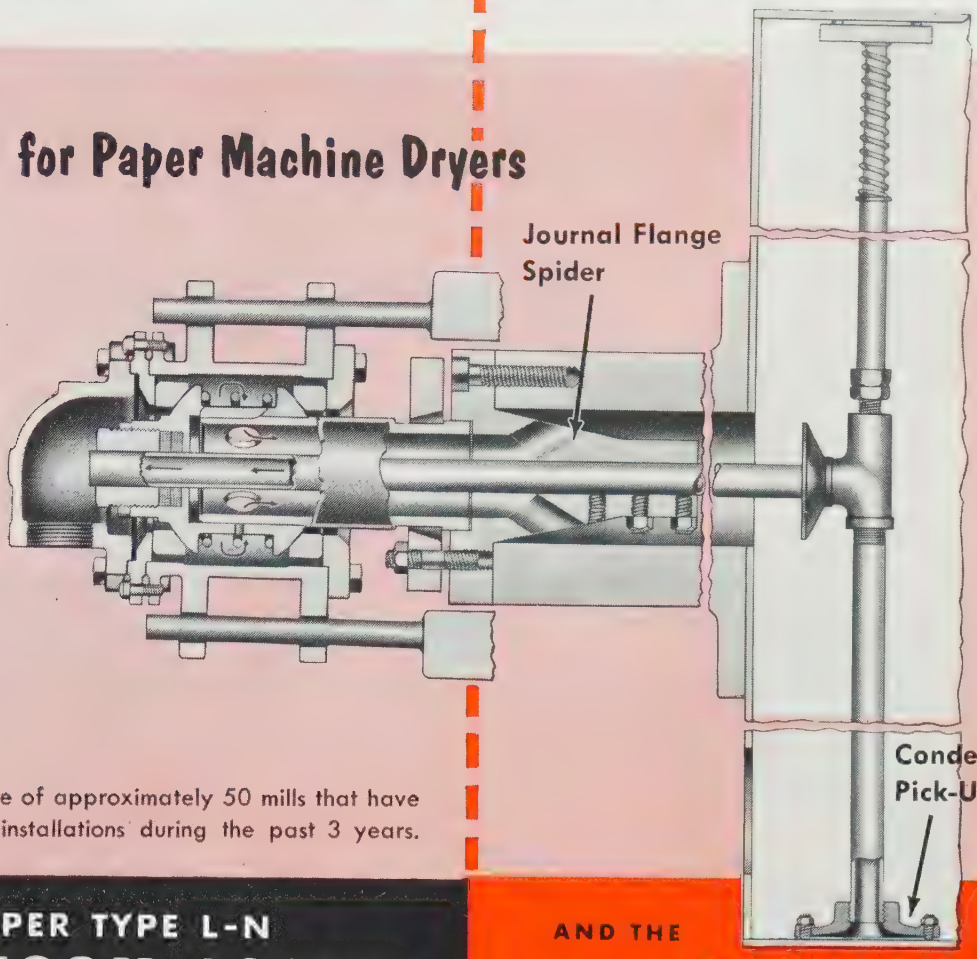
60 Park Place, Newark, N.J.

Plants: Harrison, N.J. • Carlstadt, N.J. • Richmond, Calif. Cedartown, Ga. • London, Canada • Mexico, D.F. • Corbeil, France • Sydney, Australia

Manufacturing Licensees Throughout the World

You've never seen a Combination like this*...

for Paper Machine Dryers



* Unless yours is one of approximately 50 mills that have made tests and installations during the past 3 years.

SUPER TYPE L-N
JOHNSON JOINT
with "Quick Release" Nipple

AND THE
NEW JOHNSON ROTARY SYPHON

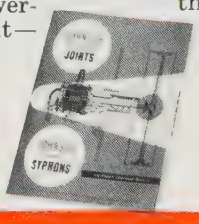
Best Design Yet for getting steam into dryer rolls with rotating syphon pipes. Needs no lubrication or adjustment. Has only a few simple parts—less chance of trouble plus easier field servicing. Assembly plate provides ready access to syphon pipe.

Floating Action—Rod supports carry all the real weight, let the rotating assembly "float" freely inside. Adaptable for machines with open or enclosed gearing.

SUPER Construction...*and Stamina*—Teams rock hard "Green Streak" seal rings with special Ni-Chrome plating, slashes friction load and increases service life.

Easy on...and off—"Quick Release" nipple uses powerful wedging action to lock joint in place. Install it—or remove it—with just an end wrench.

Engineers' Data Book summarizes research behind this new development, has full technical information. Ask for copy of: "Condensate Behavior in Paper Machines."



Better Drainage of dryer rolls results from a new concept of condensate pick-up design. Holds condensate to a minimum. Rotary Syphon can be located any place along the dryer shell. Helps to reduce horsepower requirements.

Higher Roll Temperatures—Thinner condensate film means better transfer of heat units to dryer shell. Better drying can be translated directly into increased production.

Easier Installation—No need to get inside dryer to drill and tap dryer head. Install right through manhole. For rolls with handholes only there's even a journal-inserted rotary syphon.

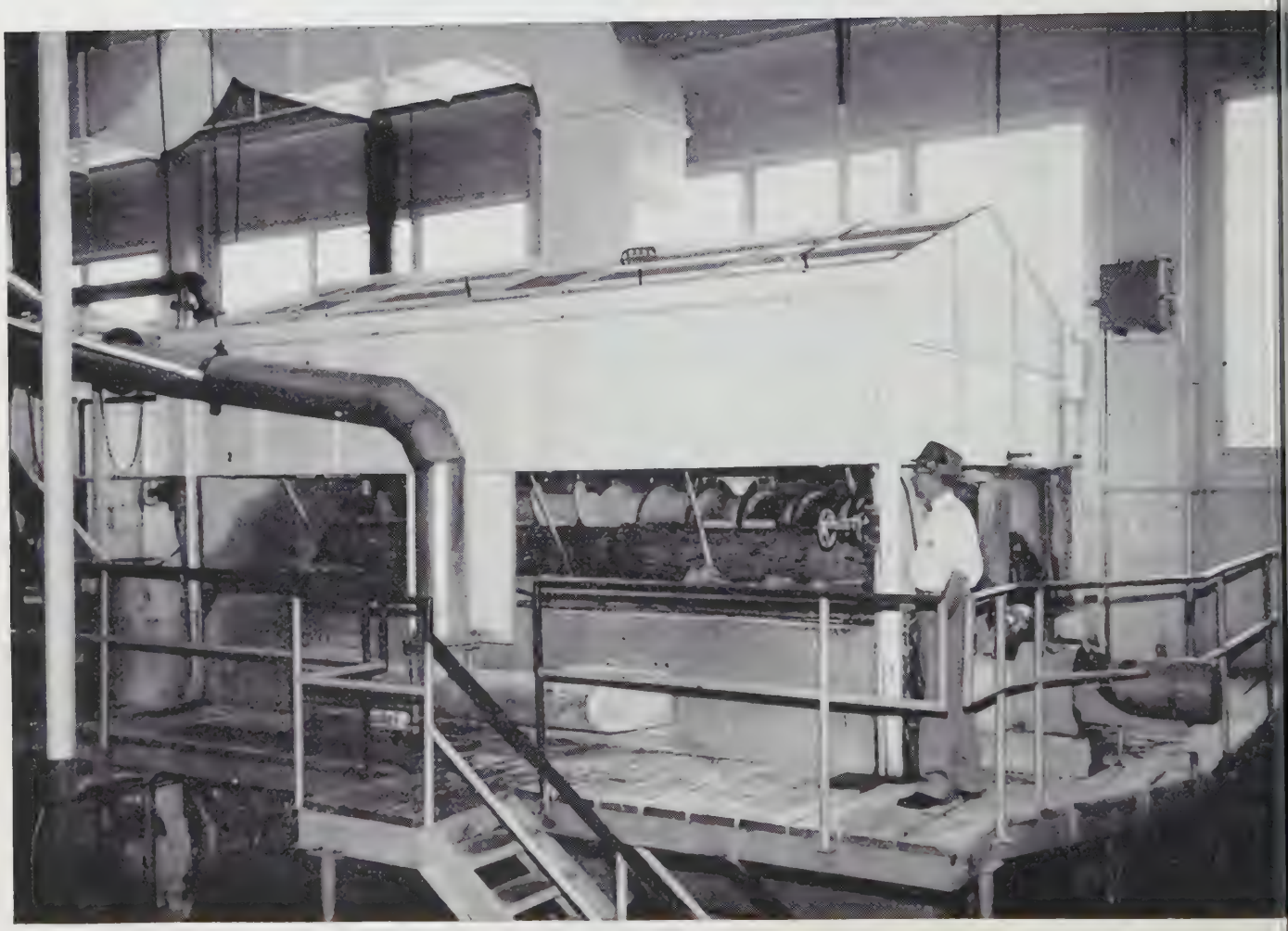
Reduced Maintenance—Only a few simple trouble-free parts. Ends bearing wear caused by unnecessary water weight and prolonged "cascading." Easily removed for inspection.

Trial offer still goes. We'll gladly furnish a pair of Joints and Syphons for 90-day trial in your own mill, without cost or obligation. Ask for details.

THE JOHNSON CORPORATION
843 Wood St., Three Rivers, Mich.
Rotary Pressure Joints • Direct Operated Solenoid Valves

New large design

OLIVER® DENHARD handles 160 tons daily



OLIVER DENHARD DISCHARGER on 8′ x 16′ groundwood washer at Elk Falls Company Limited, division of Crown Zellerbach Canada Limited, Vancouver Island, B.C. Pick-up roll is 15½″ O.D. Unit operates at a speed of 4 R.P.M. on the washer, handling up to 200 AD tons daily.

DISCHARGER

on a groundwood washer

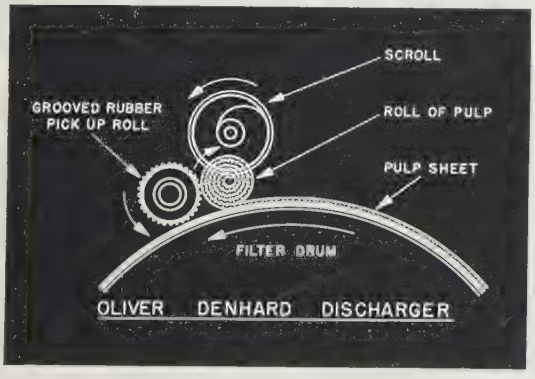
at Crown Zellerbach plant

For many years the Oliver Denhard Discharger has been successfully used on vacuum type groundwood thickeners. Now a large size has been developed which not only permits higher R.P.M. (and thus capacity) on groundwood thickeners, but also makes it practical to use this efficient device on groundwood washers, involving much higher tonnages than previously contemplated.

For example, Elk Falls Company Limited, a division of Crown Zellerbach Canada Limited, has recently put into operation a Denhard Discharger on a groundwood washer handling 160 AD tons daily. A second unit has been ordered. A Denhard Discharger of similar size is also being used on a vacuum groundwood thickener, permitting cylinder speeds in excess of 7½ R.P.M.

The Denhard Discharger on a groundwood washer makes possible a higher discharge consistency—in the order of 8 to 9% AD—than the conventional hydraulic doctor. Water consumption of the hydraulic doctor is eliminated, resulting in a higher stock temperature and a reduction in the amount of slime formation.

If you already have an Oliver Denhard Discharger in operation with a groundwood thickener, use of this new, larger size may permit a faster cylinder speed and higher capacity. Installation in place of a conventional hydraulic doctor on a groundwood washer will pay immediate dividends in terms of higher discharge consistency and saving of water. Write to Dorr-Oliver Incorporated, Stamford, Conn.



SIMPLE OPERATION of the Oliver Denhard Discharger is shown in this diagram. A grooved rubber pick-up roll starts the pulp sheet rolling up on itself like a carpet. A scroll carries the pulp to either end of the unit for discharge. Since nothing touches the facing wire but the pulp itself, maximum wire life is assured, together with a minimum of wire blinding.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

Now you can fight corrosion ... and Win!

Corite reinforced plastic installations found effective and economical by pulp and paper mills

Here is good news for management men who have become increasingly alarmed at rising costs for replacement of corrosion-damaged equipment. Out of wide acquaintance with difficult corrosion problems in the pulp and paper industry, Corite-Reynolds engineers have developed effective, yet economical, methods of combating corrosion through use of fiberglass reinforced plastics.

For example, we have found that superior corrosion-resistant polyester resins effectively resist the harmful action of chemicals used in sulphate and sulfite bleaching operations. These resins are also resistant to the fumes and solutions of chlorine, hypochlorite, chlorine dioxide and peroxide bleaching processes.

Since Corite reinforced plastic, manufactured of these resins, lends itself admirably to fabrication, we are able to supply an almost limitless variety of corrosion-resistant pressure and drain pipe, ducts, covers, hoods, tanks, and fans to meet your requirements.

So . . . if you're tired of unnecessary equipment losses . . . if you're anxious to fight the costly corrosion problem *and win* . . . drop us a line today. Our engineers will be happy to tackle your problems and suggest possible solutions to you.

Light in weight and easy to install, Corite's molded reinforced plastic installations will withstand temperatures ranging up to 300 degrees F. They have been found useful in the following areas:

Pulping — **Bleaching**
Digester — **Evaporator**
Chemical Process and Recovery
Chlorine Dioxide Generation
Paper Mill Drier Hoods

CORITE-REYNOLDS CORPORATION

455 Jarvis Avenue • DesPlaines, Illinois • CYpress 9-3321

Corrosion Engineers • **Reinforced Plastics**

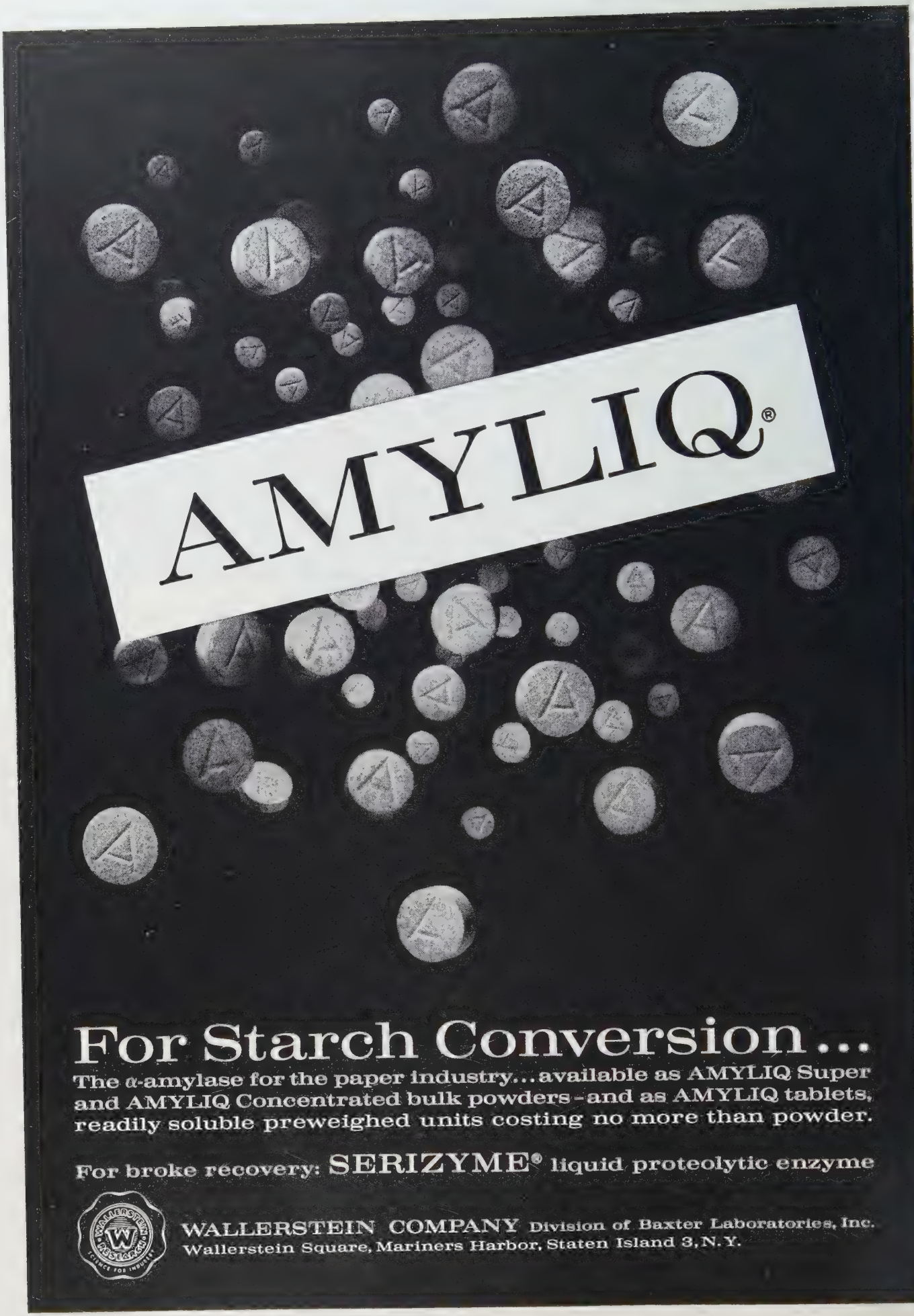
FOR THE LIFE OF RILEY... ORR FELTS

Perhaps that's stretching it a little but the fact remains that the long experience of Orr engineers plus rigid controls at every stage of the production process assures the mills of exactly the right felts for every machine need.

Get in touch with Orr the very next time any felt problem arises. Orr can be of real service to you.

ORR FELT & BLANKET CO.

PIQUA, OHIO

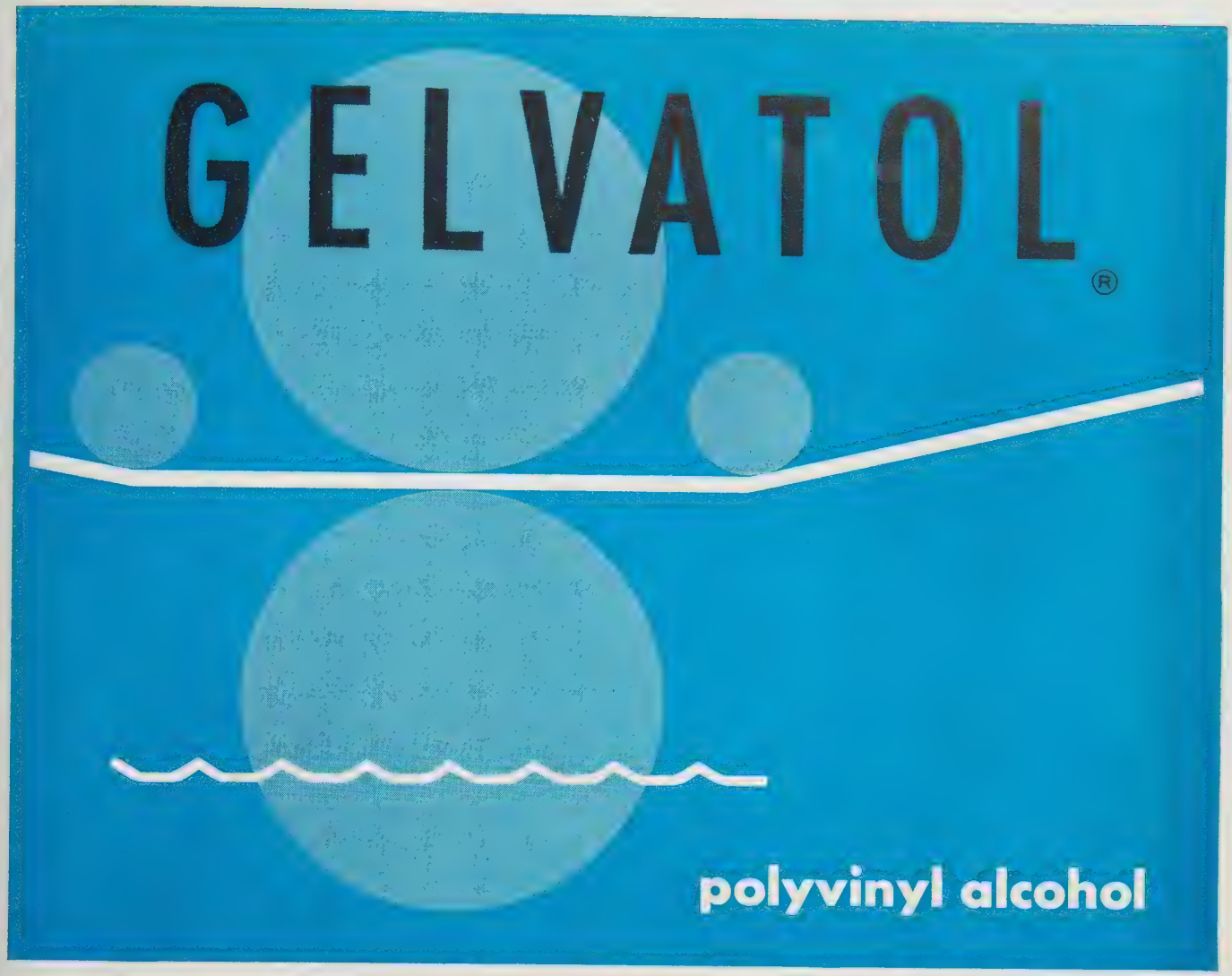


For Starch Conversion...

The α-amylase for the paper industry...available as AMYLIQ Super and AMYLIQ Concentrated bulk powders–and as AMYLIQ tablets, readily soluble preweighed units costing no more than powder.

For broke recovery: SERIZYME® liquid proteolytic enzyme

WALLERSTEIN COMPANY Division of Baxter Laboratories, Inc.
Wallerstein Square, Mariners Harbor, Staten Island 3, N.Y.



brings out the best in pigment bindings, coatings and sizings

Leading paper converters find GELVATOL Resins highly effective for product improvement. GELVATOL is granular, not a dusty powder. Goes into solution quickly. No lumping. GELVATOL may be applied from size tub, size press, water box or in coating mixes.

Improved Ink Hold-out. GELVATOL reduces ink consumption of even highly absorbent stocks. As little as ¼ pound per ream gives Vanceometer readings of 90-95.

Improved Pigment Binding. The greater adhesive power of GELVATOL and lower binder requirements of the coating produce a brighter, more opaque sheet with excellent print qualities.

Improved Strength. Sizing with GELVATOL increases Mullen, pick resistance and fold endurance.

Increased Wax Hold-out. Sizings based on GELVATOL have superior film forming properties which give wax hold-out superior to common sizes.

GELVATOL CHARACTERISTICS

Resin Type	Viscosity, cps. (4% Solution)	% Residual Polyvinyl Acetate	% Hydrolysis
1–90	55–65	0–2	100–99
3–90	45–55	2–4	99–97.9
20–90	35–45	19.5–22.7	89–87
1–60	28–32	0–2	100–99
3–60	23–28	2–4	99–97.9
20–60	21–25	19.5–22.7	89–87
1–30	4–6	0–3	100–98.5
20–30	4–6	19.5–21.5	89–87.7
40–20	2–3	37–42	77–72.9
40–10	1.3–2	37–42	77–72.9

For complete technical information, write Shawinigan Resins Corporation, Springfield 1, Mass., Dept. 8F.

SALES OFFICES: ATLANTA CHICAGO LOS ANGELES NEW YORK SPRINGFIELD CLEVELAND SAN FRANCISCO GREENSBORO ST. LOUIS

GELVATOL® *polyvinyl alcohol by* SHAWINIGAN RESINS®

KEEVER VICTOR STARCH

a blend of QUALITY STARCHES made to meet your EXACT requirements

How often do your paper-making problems point the finger to starch problems?

Then get acquainted with Keever — and Victor Starch. It's the only blend of wheat and corn now available to the paper industry.

Tests prove that Victor Blended Starch provides a clearer film, greater adhesive strength, more flexibility, a better fiber lay.

Victor Starch makes it possible to produce a formula best suited to nearly every starch operation in paper making.

Keever starch technicians will help you work out the ideal formula variations that make Victor Starch "custom-made" for individual requirements.

For additional information, write for Keever Data Sheet 170.

THE KEEVER STARCH COMPANY

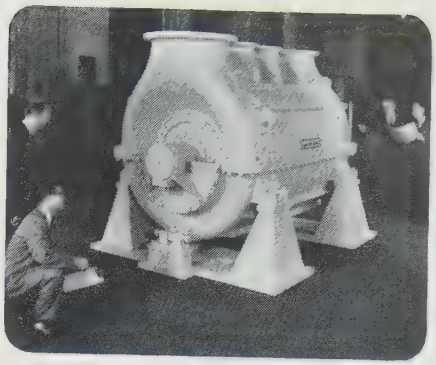
538 East Town Street, Columbus 15, Ohio

Processors of grain products for industry since 1898

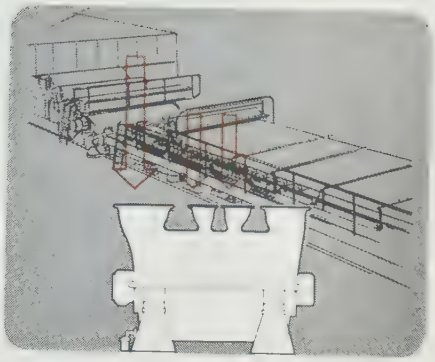
A Short Picture Story about the

BIG NEWS

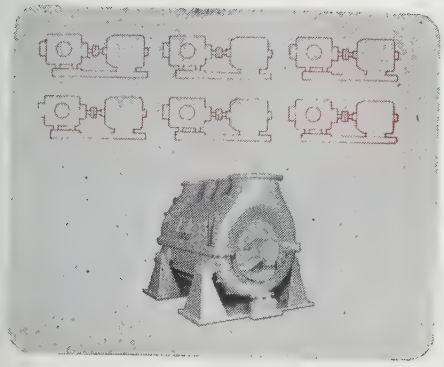
in Paper Making



1. It's the Ingersoll-Rand Central Vacuum System for paper mills — a new application for centrifugal exhausters that opens a new era for the American paper industry because . . .

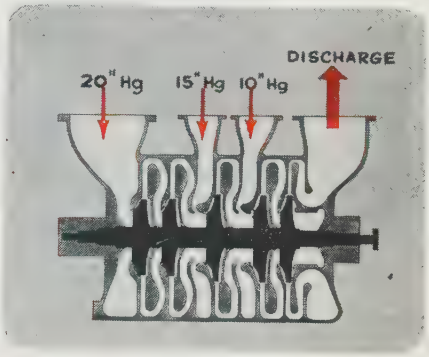


2. this one unit, with associated separators and controls, constitutes a complete system that meets all vacuum requirements for an entire paper-making machine. For example . . .

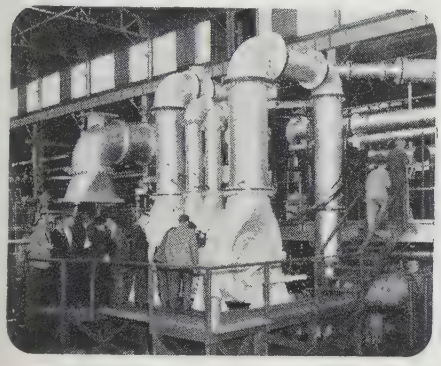


3. one 1,065-hp exhauster has taken the place of six wet vacuum pumps totaling 1,285 hp — a net saving of 225 hp! In addition to saving up to 25% on driver horsepower . .

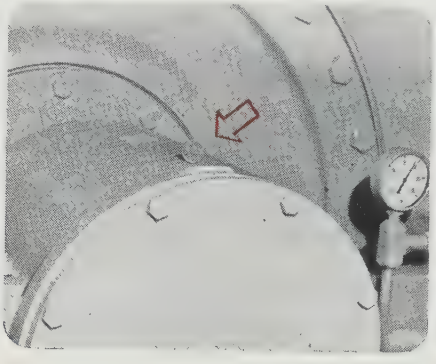
4. from 70 to 90% of its power is recovered as hot air for drying — saving the cost of steam and the capital investment for air heater equipment. All this is possible because . . .



5. the multi-stage centrifugal exhauster is designed with multiple inlets that provide three separate vacuum pressures as required by the installation. To see this innovation . . .



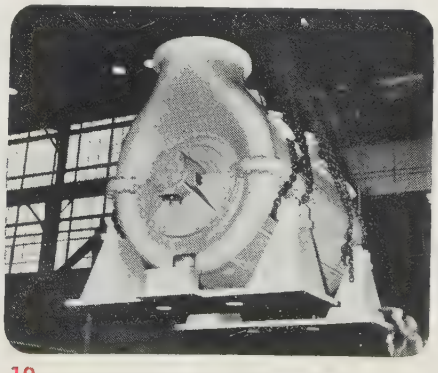
6. paper makers from all over the country visited an open-house demonstration at the Ingersoll-Rand plant, where the Central Vacuum System was in actual operation. Here they saw that . . .



7. the centrifugal exhauster ran so smoothly that a coin stood on edge on the bearing housing without a quiver. And, through a window in the casing . . .

8. they could see that the discharge air was completely dry, without even a trace of moisture, making it an ideal heat source for drying. This is due to . . .

9. the unique primary separators designed by Ingersoll-Rand — units that proved so efficient in removing moisture that secondary separators are used only for back-up protection. Later . . .



10. the first Central Vacuum System ever built in America was shipped to a leading paper mill. Two other systems are already on order. For complete information, send for Bulletin 8289.

Ingersoll-Rand®

310A12 11 Broadway, New York 4, N.Y.

COMPRESSORS • VACUUM SYSTEMS
CENTRIFUGAL PUMPS • AIR MOTORS
& HOISTS • AIR TOOLS • LOG BARKERS
REFRIGERATING UNITS

HODAG SURFACE ACTIVE CHEMICALS FOR THE PAPER INDUSTRY

Antifoams – pulp mill, paper machine, coatings and sizes

Silicone release coatings and antifoams

Starch and coating additives

Flocculating agents and retention aids

Wetting and re-wetting agents

Softeners

Miscellaneous surface active agents

Pulp and paper mills use Hodag products to speed production, improve quality and reduce costs. Write for literature. Hodag Chemical Corporation, 7247 North Central Park Avenue, Skokie, Illinois.

HODAG

HCC-1-200

Solve your coating problems

<u>economically</u> with these unique

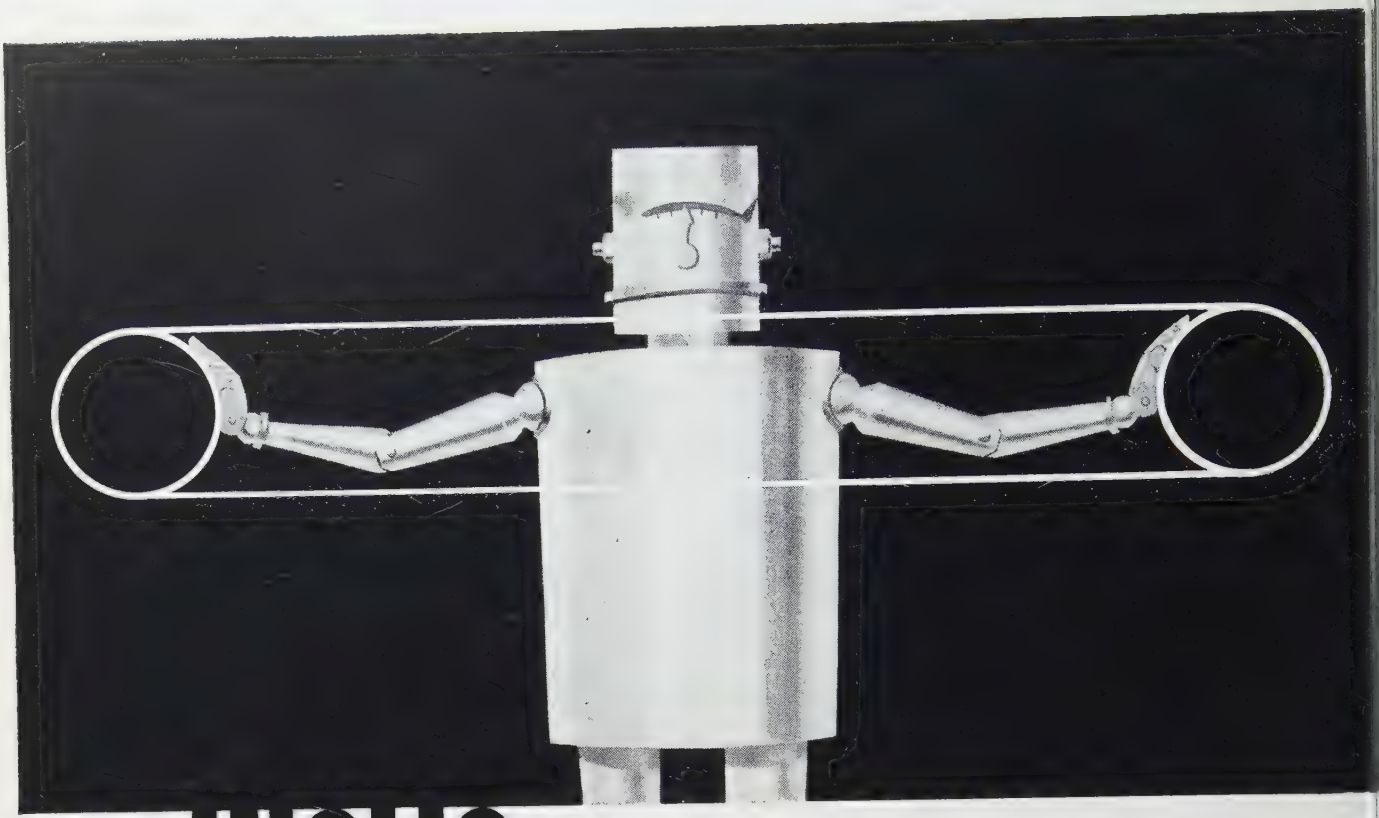
new families of starches . . .

MILO-FILM®
and GLOBE©
EASY-ENZ
starches

WRITE OR PHONE *Corn Products for expert technical assistance . . .*
helpful data on these fine products for Papermakers:
BUFFALO® • GLOBE® • TEN-O-FILM® • MILO-FILM® • TEXO-FILM® • FOXHEAD® • CORAGUM® • CORAGUM® FD • CRESCENT® CLARO® starches • GLOBE® and GLOBE® LAM-O-DEX® dextrines and gums • EXCELLO® dextrines

CORN PRODUCTS COMPANY INDUSTRIAL DIVISION • 10 East 56 Street, New York 22, N. Y.

Newest improvement in paper making!



INGLIS WIRE TENSION DEVICE

. . . lengthens wire life through automatic control

The newest Inglis contribution to better paper making takes the business of wire tension adjustment out of human hands—maintains the appropriate uniform tension automatically. The device lengthens wire life by compensating automatically for natural stretch, and by positively eliminating the danger of damage from overtension in a wire cooling after hot stock is removed. When required, easy manual changes can be made, allowing the paper maker to use his judgment in selecting the best tension for different wires. Tension settings may be recorded for later reference.

From head box to winder, paper machinery by Inglis is designed and built to keep the modern paper maker in step with modern production demands.

For full details of the Inglis Wire Tension Device, write for publication P.P. 604.

Inglis

PAPER MAKING MACHINERY

JOHN INGLIS CO. LIMITED

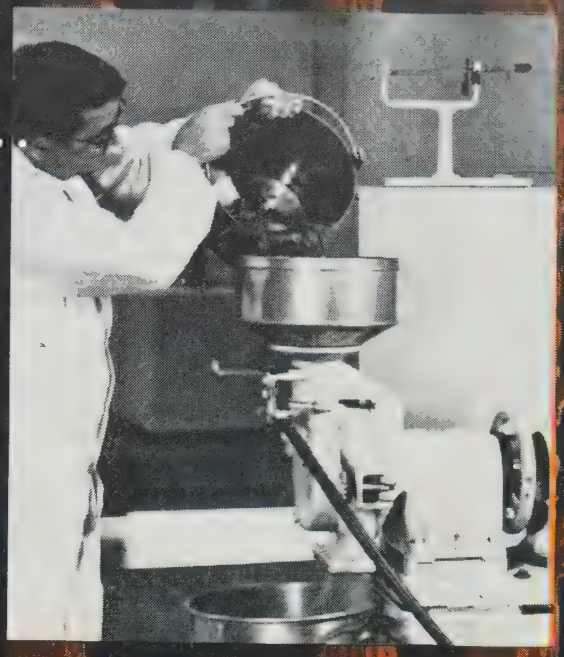
14 STRACHAN AVENUE, TORONTO, CANADA

Sales and Service throughout Canada and the U.S.A.

K148

WHEN THE CHIPS ARE DOWN . . .

fmc's paper research team goes to work on your problem!



Soda ash, caustic and chlorine users now get unparalleled technical assistance from FMC in solving tough paper problems.

The new wing recently added to our Princeton Research Center brings together paper experts from three divisions of FMC Inorganic Chemicals Department to form a customer service team with unusual depth of experience in this specialized field.

Working in one of the best equipped paper laboratories outside the paper industry, these technicians are able to duplicate fundamental paper manufacturing steps and to carefully test and evaluate the results. Their work is aided immeasurably by our modern analytical research laboratories at the same location.

Next time you have a problem, call on your nearest FMC district office.

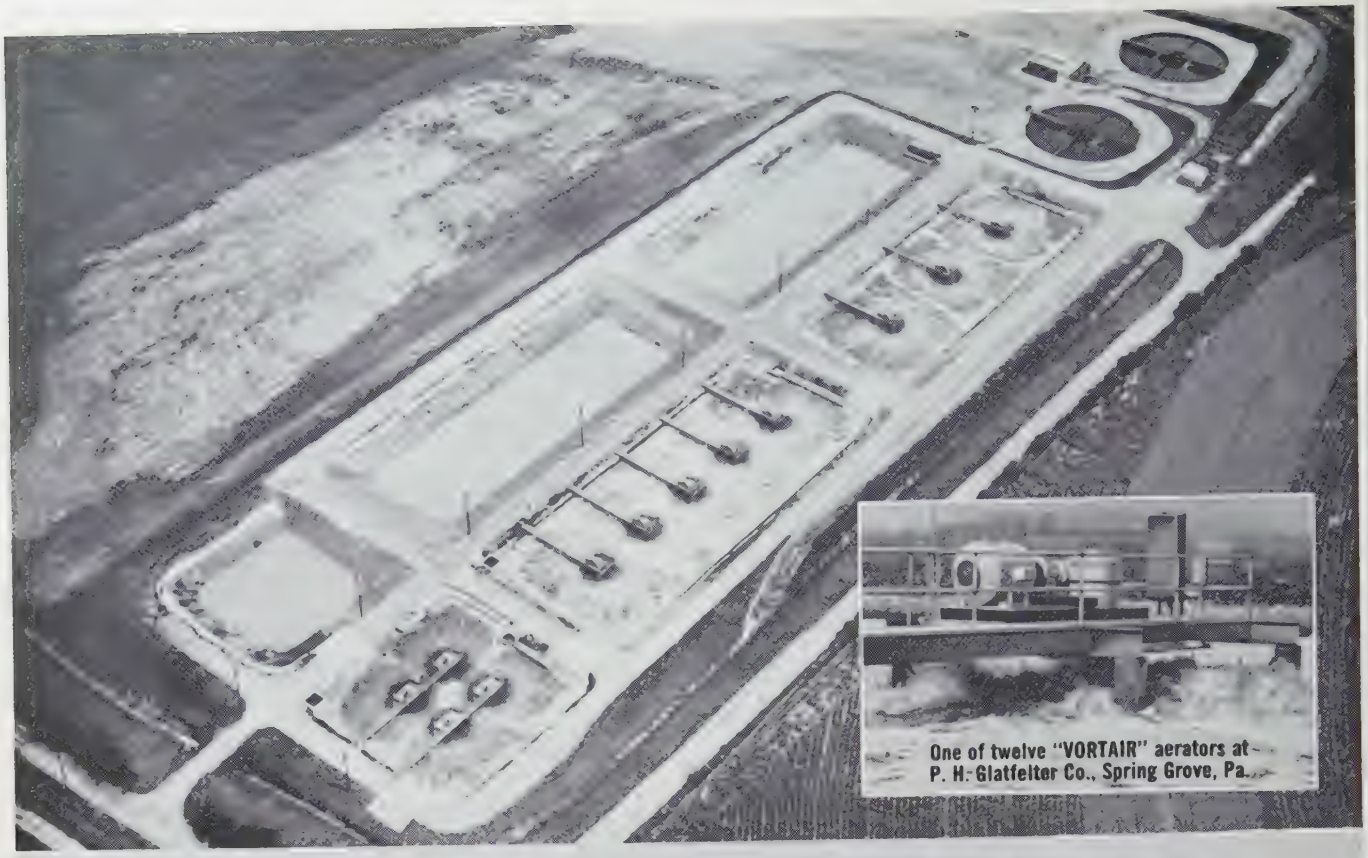
CHLORINE

SODA ASH
Light and Dense Grades

CAUSTIC SODA
50% and 73% Liquid,
Regular and Rayon Grades;
Flake, Solid and Ground

fmc CORPORATION

CHLOR-ALKALI DIVISION
161 E. 42nd Street, New York 17



The VORTAIR® aerator by INFILCO Inc.

dissolves up to 4 pounds of oxygen per hour per motor horse power in sewage or industrial wastes

For biological treatment of wastes, this surface aerator provides a most economical means of oxygen transfer — in new activated sludge plants, in plant expansions, in stabilization ponds or in oxygen-deficient streams.

Heretofore, successful application of mechanical surface aerators has been limited by low oxygen input and poor mixing. Now, as a result of extensive hydrodynamic research, the "VORTAIR" aerator provides high oxygen input per motor horse power, and good mixing.

Elimination of air compressors cuts installation, maintenance and power costs up to 45%. Installation on platforms, bridges or rafts is simple and economical.

Performance in many municipal and industrial plants proves the efficiency and economy of the "VORTAIR" aerator. Standard models are available from 1 to 150 horsepower.

The "VORTAIR" aerator merits your consideration. For more information write today for Bulletin 6620-A.

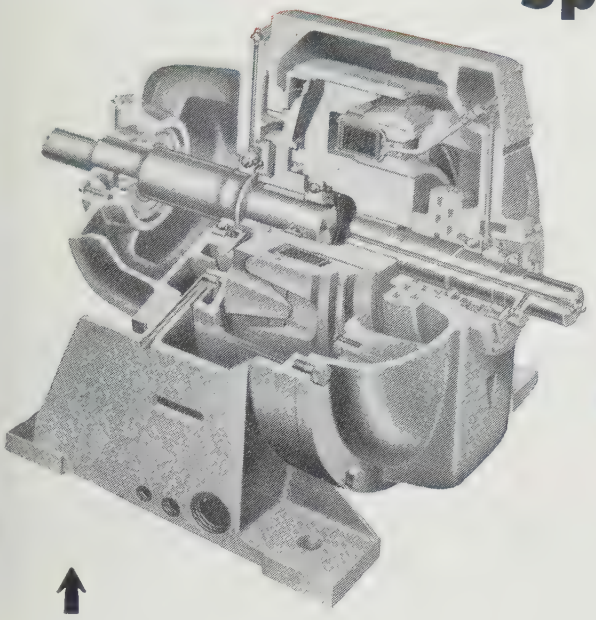
INFILCO GENERAL AMERICAN

INFILCO Inc. General Offices — Tucson, Arizona

Field offices throughout the United States and in other countries.

Subsidiary of General American Transportation Corporation

The BEST Solution to Difficult Speed Control Problems—

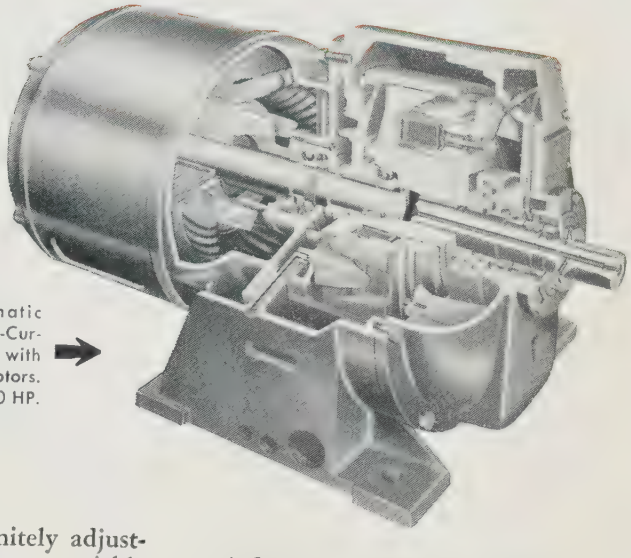


Dynamatic Liquid-Cooled Couplings provide infinitely adjustable speeds for nearly every application from 3 to 150 HP. Note the absence of slip rings, brushes, and commutators. Heavy-duty types with capacities up to 5,000 HP are also available.

EATON

DYNAMATIC®

LIQUID-COOLED EDDY-CURRENT COUPLINGS and DRIVES



"Dynaspede" Drives are Dynamatic Liquid-Cooled, Stationary-Field Eddy-Current Couplings mounted integrally with standard, D-flange, squirrel cage motors. Available in capacities from 3 to 150 HP.

Here's Why—

Dynamatic Liquid-Cooled Couplings and Drives provide infinitely adjustable speed from a constant speed source—or constant speed from a variable speed source. They operate on standard alternating current. Rotary power is transmitted through the coupling by an electromagnetic reaction between the driving and driven members of the unit—there is no mechanical contact of rotating members to cause wear and require adjustment or replacement.

A wide range of standard and special control features may be obtained from a remotely-mounted electronic control system. Infinite speed adjustment, constant speed control, on-off clutch control, torque limit, acceleration control, inching, and threading are a few of the many functions available. The addition of an eddy-current brake to standard couplings or drives provides smooth, cushioned stops and controlled deceleration.

Liquid-Cooled Dynamatic Couplings and Drives deliver more horsepower than other types of the same physical size, thus conserving space in a busy machine area. Efficient heat dissipation permits continued operation at low speeds, or stall with full load.

Completely enclosed, Dynamatic liquid-cooled units are protected from dust, dirt, and other atmospheric impurities. Dynamatic design involves no brushes or slip rings; there is no possibility of arcing. With simple modification these units can be made explosion-resistant for hazardous applications.

Infinitely Adjustable Speeds from AC Power

★

Smooth, Quiet Operation from Cushioned Starts

★

Wide Range of Control Functions

★

No Slip Rings, Brushes or Commutators

★

Completely Enclosed Design

★

Greaseable Bearings

Send for Our New Illustrated Bulletin.

EATON

DYNAMATIC DIVISION

MANUFACTURING COMPANY

3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Dow certification on Latexes 630 and X3352 now available for food package applications

New regulation issued by FDA shows these latexes are in compliance with 1958 Food Additive Amendment

Dow can now furnish paper and paperboard manufacturers with Latexes 630 and X3352 which comply with requirements for direct food contact.

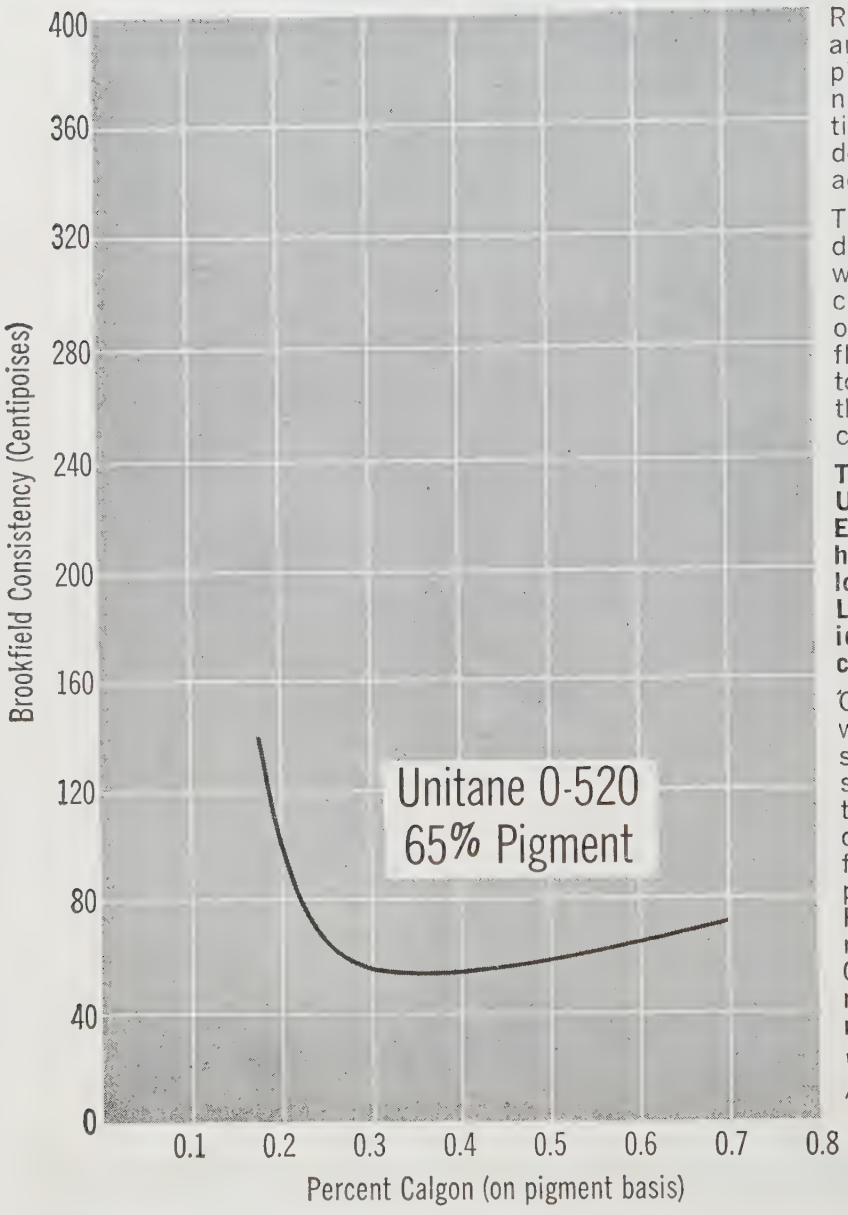
Dow Latex 630 offers exceptional starch compatibility, excellent mechanical stability, and outstanding pick resistance. It can provide packagers with superior printability, paper and paperboard that permit clear, sharp, true-to-life reproduction. Its cost is low, its quality high.

Dow Latex X3352 is a low-odor latex which develops excellent printability and ink holdout, good gloss and brightness, and excellent foldability in coated paper and paperboard. Mechanical stability on various coating machines is excellent.

For full information on these or other Dow latexes for coating applications, call or write your nearest Dow sales office.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan

smoother, more economical paper coatings assured with new Unitane® 0-520



Recognizing the trend toward smoother and more economical paper coatings employing relatively mild dispersion techniques, Cyanamid has produced a new titanium dioxide pigment, Unitane 0-520 designed especially to meet the most exacting requirements of the paper coater.

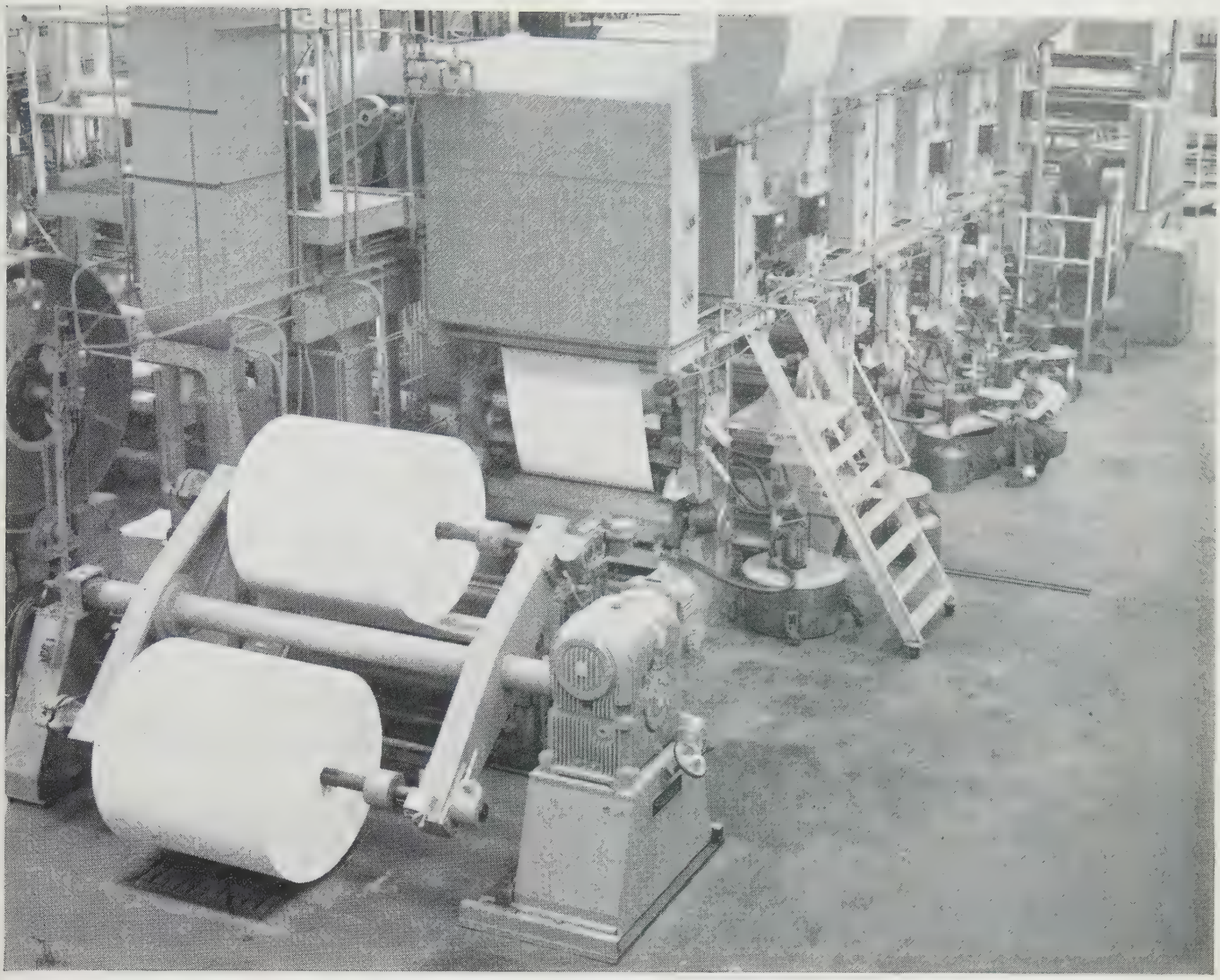
The curve illustrates the low dispersant demand and low viscosity of coatings made with Unitane 0-520. The very slight increase in viscosity with increasing amounts of dispersant gives the coating formulator flexibility of formulation. It enables him to control deflocculation and to sequester the polyvalent ions from hard water, calcium carbonate and other fillers.

These desirable features are found in Unitane 0-520:
Easy to disperse — excellent response to high speed equipment • Low consistency — low water demand • High pigment loading • Low abrasion factor • Extremely low residue (325 screen) — promotes smoother coatings

Comparisons with Unitane 0-110, a type well-known in the paper industry, have shown that the new Unitane 0-520 has the same good opacity in all coating applications. A comprehensive report of the tests on Unitane 0-520 and the currently offered paper coatings types has been prepared and is available from your Cyanamid Pigments representative. Why not call him now and let him show you how Unitane 0-520 can give you smoother, more economical coatings. A generous sample is ready for your tests. *Whiter and Brighter with Unitane*

CYANAMID

AMERICAN CYANAMID COMPANY PIGMENTS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK



"Encore" Says Reynolds Tobacco to INTA-ROTO Rex

Performance of First Sells Second Inta-Roto Press to R. J. Reynolds Tobacco Company's Archer Aluminum Division

Continuous operation; produces *millions* of cigarette wraps *daily*. Profitable short runs, too. Fast changeover; exceptional versatility, handles a large variety of packaging materials.

The Archer machine is equipped for in-line thermoplastic laminating and embossing before and after printing. It can print, laminate, emboss, and rewind or sheet. Pre-makeready, and quick, inexpensive changeover is permitted by interchange of complete printing and inking units (fully enclosed, completely splash proof).

Write today for more information about the Inta-Roto Rex, or other Inta-Roto machines.

GIVE US THE PROBLEM! Our engineering staff is now available for contract engineering. Our experience in the fields of printing, coating, laminating and slitting gives us the "inside track" on problems of the converter.

INTA-ROTO MACHINE CO., INC.

P. O. Box 454 Byrd Airport, Richmond 3, Va. Phone REpublic 7-4181

Canadian Representative: G. W. Keates, 133 Flora Drive, Scarborough, Ontario

VISIT THE INTA-ROTO BOOTH 823, PMMI CONVENTION

Photo by Harold M. Lambert

*Idea submitted by Charles Dufon,
Packaging Corp. of America, Filer City, Michigan

HAM FELTZ says:

"Reminds me of HAMILTON Felts . . . they save money every day!"

"The day you start using Hamilton Felts
you start saving money.
Hamilton Felts reduce the high cost
of down-time because they are
engineered for longer machine life
and trouble-free performance.
They are 'water-conditioned'
for faster water removal,
deliver drier sheets to the driers,
keep your machines running at top speed
with fewer stops and less broke . . .
When new felts *are* required
Hamilton Felts provide further savings
because they are pre-shrunk . . .
broken-in to fit *your* machine.
That means less down-time for changeovers.
One of our 'standard 300' technically proven styles
should solve *your* problem.
If it won't, we will be happy
to design a Hamilton Felt that will.
Just ask your Hamilton Felts Service Salesman
how we can help you
turn out more tonnage with less broke.
Or write us today!"

*WIN . . . *A NEW Shakespeare Spincast Fishing Outfit!*

"What famous place reminds you of Hamilton Felts? Tell us why in a few words; sign your name and address and name of company. Each idea from a U.S. papermaker that we use wins a new 1961 model Shakespeare Spincast Rod and Reel—FREE! When identical winning ideas are submitted by 2 or more papermakers, the one with the earliest postmark will be considered the winner. Every U.S. papermaker *entrant* receives a famous Rex Spoon fishing lure — FREE. Send me your suggestion — today.
Ham Feltz, 612 First National Bank Bldg., Dept. T,
Cincinnati 2, Ohio."

YOU CAN'T BEAT
Hamilton
FELTS

SHULER & BENNINGHOFEN, HAMILTON, OHIO

You don't have to replace stock pumps for the sake of one part.

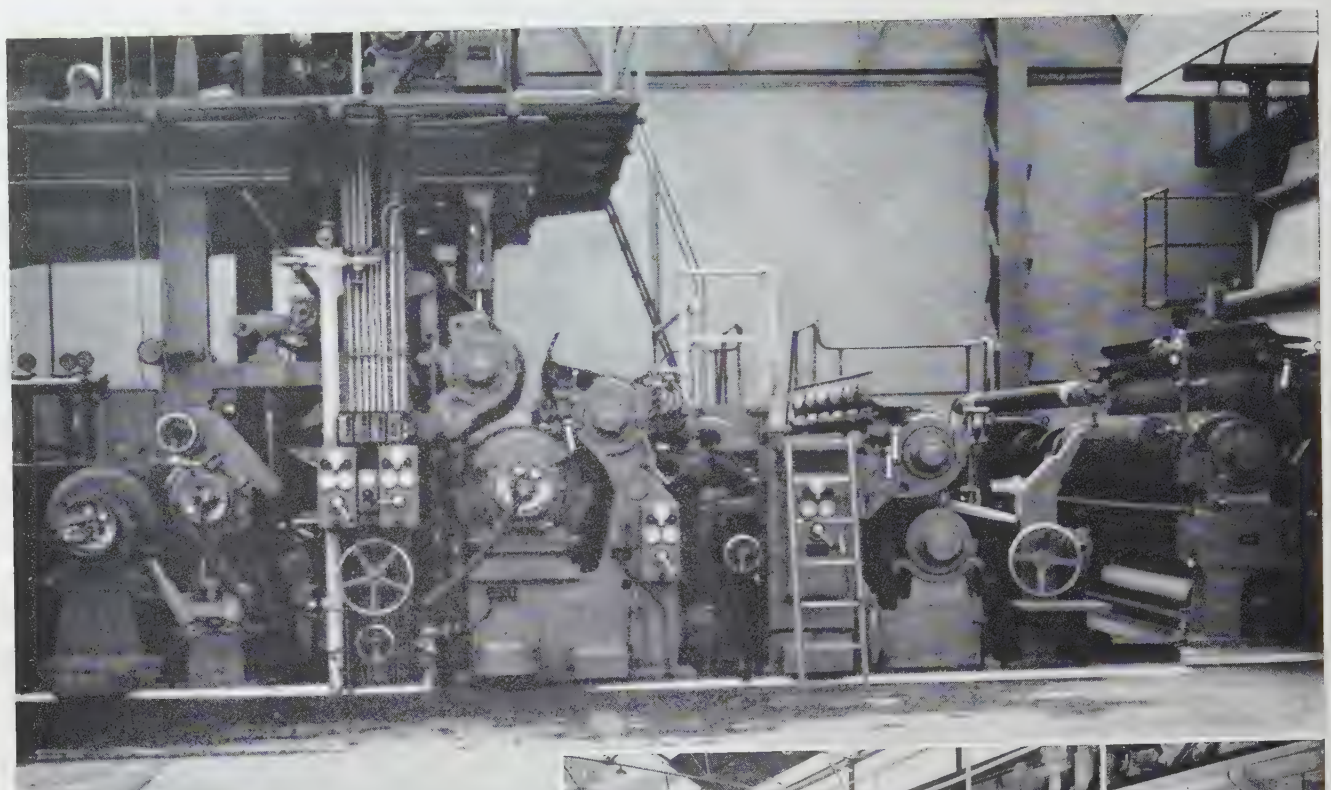
On Goulds Model 3135, for example, side plates, shaft sleeves, bushings and rotating parts are all renewable. When a side plate wears, that's all you replace—and at a fraction of the cost of a casing replacement. You save on labor and downtime costs, too.

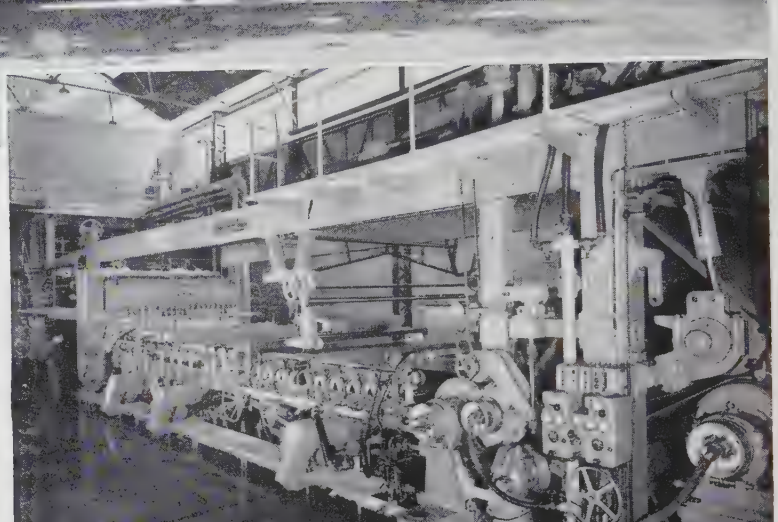
Cut spare parts inventory. Obviously, the stocking of renewable parts requires less dollars and space than new casings and pumps . . . allows replacement of parts most subject to wear with tough alloys such as stainless steel when needed.

Like more detailed information? Send for bulletin on Goulds Model 3135: performance curves, conversion chart of ton output to G.P.M., an illustrated step-by-step description of the fast removal of the rotating element, and other useful information.

Goulds Pumps, Inc., Dept. TA-111, Seneca Falls, New York.

GOULDS PUMPS





On the 2nd day after the test run

the guaranteed production was already exceeded by more than 20%, a proof of first class design and workmanship.

The illustrations show the wire and press sections of a special machine which produces thin paper at high speeds.

Technical details will gladly be supplied on demand.

O. DÖRRIES A.G. DÜREN

EisengieBerei und Maschinenfabriken • Western Germany

Agents: Bulkley, Dunton Pulp Company, Inc. 295 Madison Avenue, New York 17, N. Y./USA
Telephone: MUrray Hill 9-6400 Telex: TWY-NY 1-2092

A "Special Detergent" for continuous washing of pickup felts

IGEPAL® CO-630

is economical, easy to apply... lengthens felt life

Because of its truly nonionic nature, Igepal CO-630 does not form insoluble precipitates with calcium and magnesium, as does soap, or anionic based detergents. This nonionic detergent is compatible with alkaline salts, acids and commonly used solvents, but contains no harmful alkalis to weaken felt.

Paper machine wet-end felts can be washed with Igepal CO-630 solutions in the usual felt conditioning units, either continuously or intermittently while running; there is a minimum of foaming action. Igepal improves drainage, is positively non-shrinking. Complete technical information supplied on request. Simply write—

From Research to Reality

GENERAL DYESTUFF COMPANY · ANTARA CHEMICALS

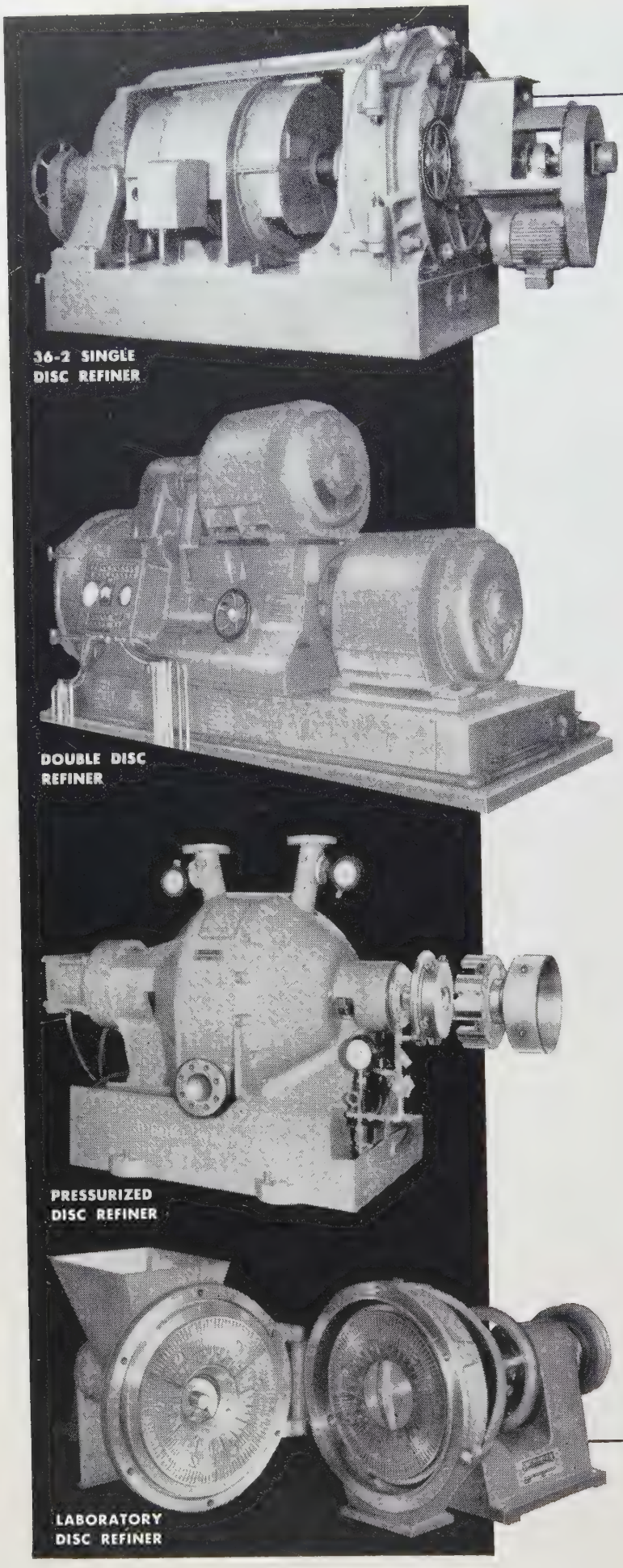
SALES DIVISIONS OF GENERAL ANILINE & FILM CORPORATION

435 HUDSON STREET • NEW YORK 14, N. Y.

gaf gdc ANTARA

SALES OFFICES: New York • Providence • Philadelphia • Charlotte • Chattanooga • Chicago Portland, Ore. • San Francisco • Los Angeles. IN CANADA: Chemical Developments of Canada, Ltd., Montreal

Igepal CO-630, manufactured by General Aniline & Film Corp., is sold outside the United States and Canada under the tradename Antarox CO-630 by distributors all over the world.



'SPROUT' REFINERS

THE YARDSTICK FOR THE INDUSTRY

These famous 'Sprouts' are in wide use throughout the world for semi-chemical pulping, bleached and unbleached; high and normal yield kraft stock refining; kraft and sulphate knotter rejects; high yield sulphite; refiner groundwood; groundwood and bull screen rejects; cold caustic pulping; bagasse, flax and straw pulping; insulation and hardboard fiber preparations; wastepaper stock refining; asplund stock secondary fiberizing; rag pulping, and many special processes.

Write for descriptive bulletins.

S W

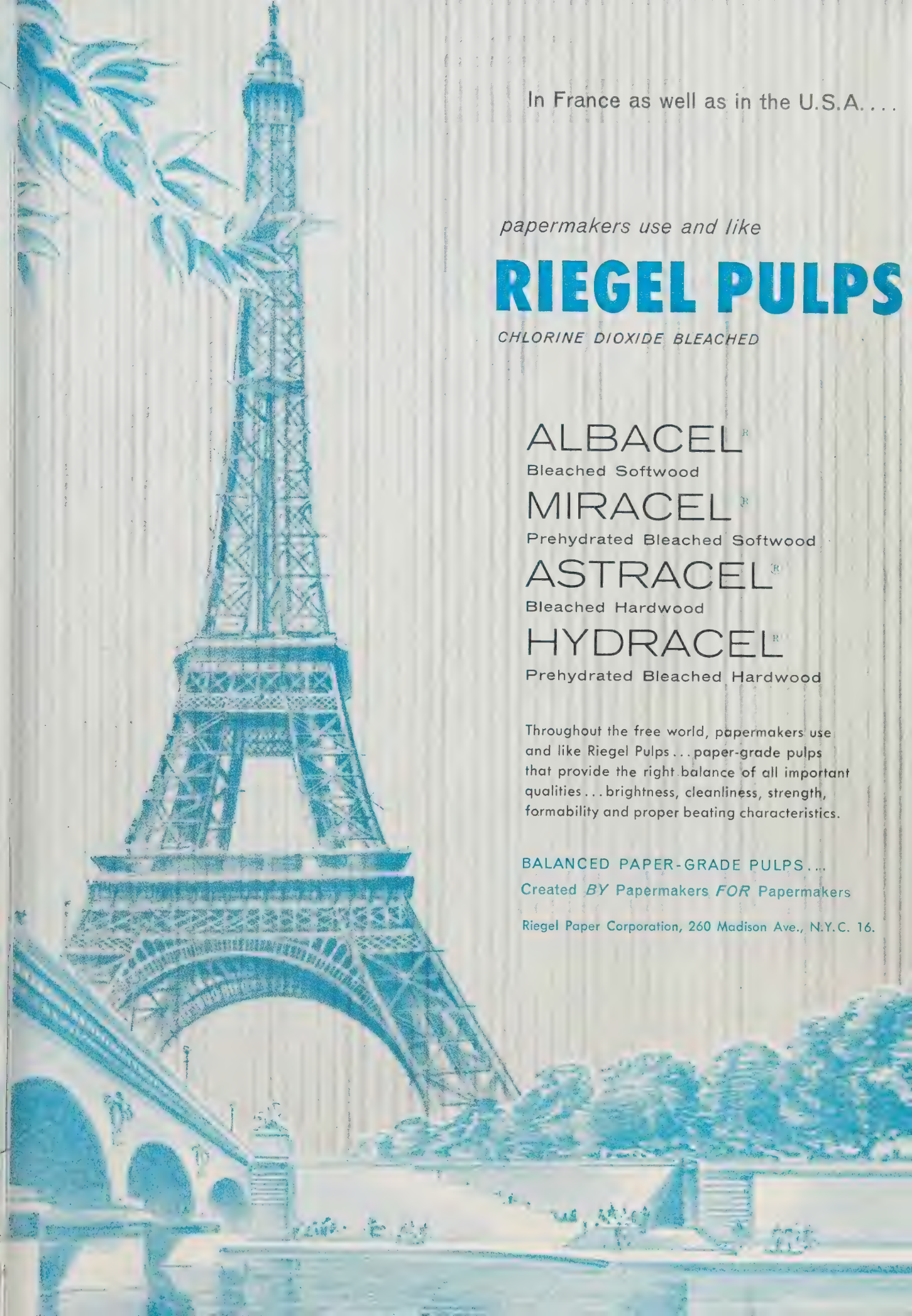
More Sprout Disc Refiners are sold than any other make

DISC REFINER SPECIALISTS

SPROUT, WALDRON & CO., INC.

MUNCY, PENNSYLVANIA, U.S.A.

Refiners • Conveyors • Feeders • Screens
Mixers • Drainers • Stock Proportioners



In France as well as in the U.S.A. . . .

papermakers use and like

RIEGEL PULPS

CHLORINE DIOXIDE BLEACHED

ALBACEL®
Bleached Softwood

MIRACEL®
Prehydrated Bleached Softwood

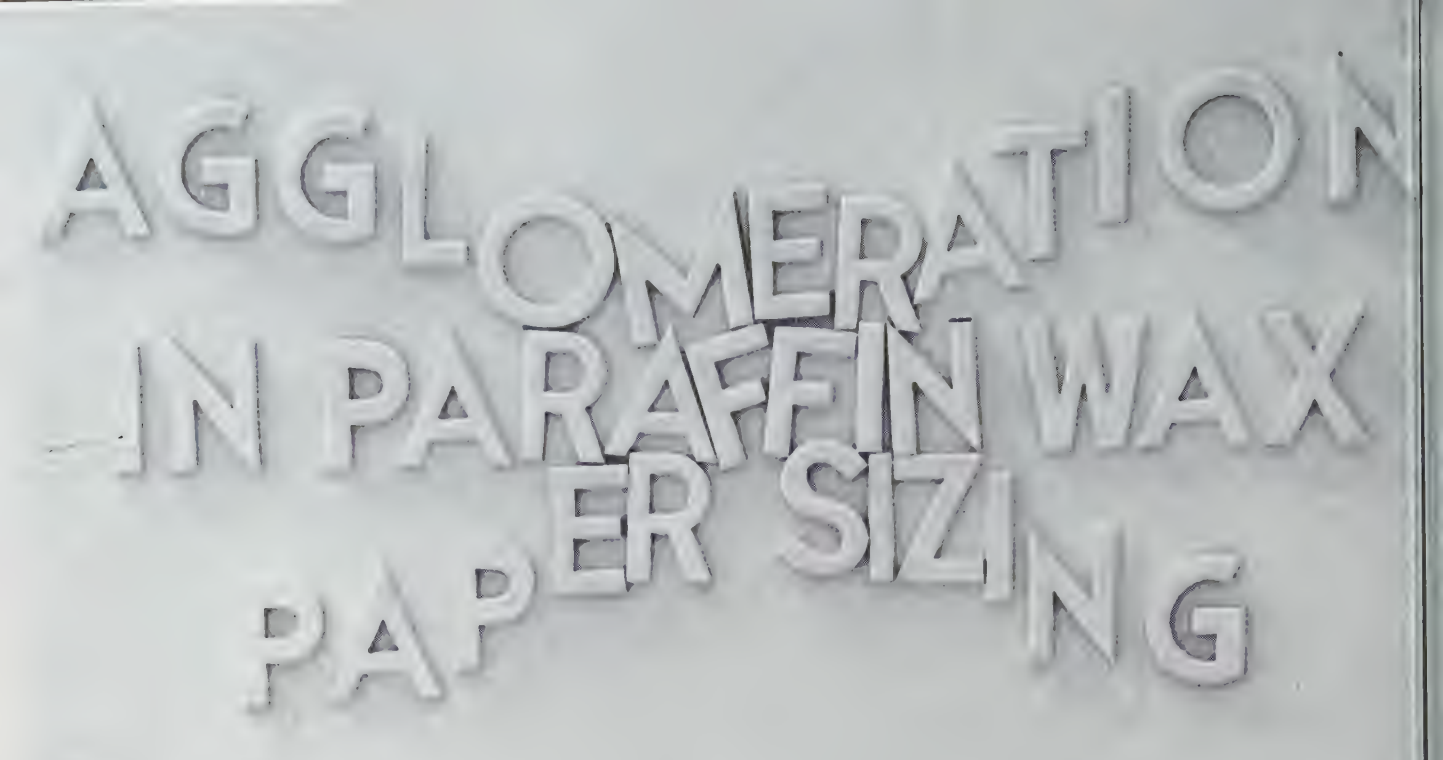
ASTRACEL®
Bleached Hardwood

HYDRACEL®
Prehydrated Bleached Hardwood

Throughout the free world, papermakers use and like Riegel Pulps . . . paper-grade pulps that provide the right balance of all important qualities . . . brightness, cleanliness, strength, formability and proper beating characteristics.

BALANCED PAPER-GRADE PULPS . . .
Created *BY* Papermakers *FOR* Papermakers

Riegel Paper Corporation, 260 Madison Ave., N.Y.C. 16.



...STOPPED BY A-C POLYETHYLENE!

Recent lab studies show that A-C® Polyethylene in paraffin wax sizings *improves the particle size of the emulsion*. It stops agglomeration by raising the softening point of paraffin. And it gives the emulsion greater mechanical stability.

Now you can have superior sizings for all types of papers, from writing to wrapping. A-C Polyethylene not only keeps emulsion particles properly dispersed—it contributes gloss, toughness, and resistance to water and chemicals.

You'll find A-C Polyethylene easy to incorporate into your regular emulsifying procedure. Or you can ask your supplier for emulsions containing A-C Polyethylene.

For technical data, write: Plastics Division, Dept. 616-T, 40 Rector Street, New York 6, N.Y. In Canada: Allied Chemical Canada, Ltd., Montreal.

PLASTICS DIVISION
40 Rector Street, New York 6, New York

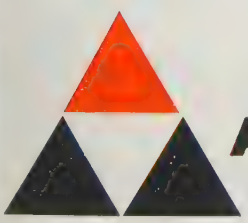
Allied Chemical

BASIC TO AMERICA'S PROGRES

we drop ed our middle name

p

For 80 years Appleton Woolen Mills has been a fine old name in papermakers' felts. But in the last few years, it has not adequately reflected the changes taking place in our products. So with full respect for tradition, we dropped our middle name. We adopted our new, simplified name and the new triangle trademark to signify new materials, new processes and new outlook at Appleton Mills. These factors add up to a better and better product, giving finer felt performance on paper machines all over the country. For the full performance story, talk to your Appleton Man . . . the man from

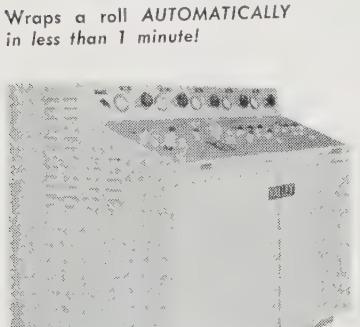


APPLETON MILLS APPLETON, WISCONSIN

NEW and REVOLUTIONARY ROLL-WRAPPING SYSTEM

PATENTS PENDING

Wraps a roll *AUTOMATICALLY in less than 1 minute!*



Each phase of automatic time cycle can be individually activated by turning control console selector switch to manual, and pressing individual operation pushbutton mounted on the console board.

wraps smoothly . . . faster . . . with minimum supervision . . . in smaller floor area . . . at lower cost

ANOTHER VALLEY FIRST! Now . . . a completely automatic, flexible right angle packaging system. Cuts wrapping paper to required size without manual settings, wraps and crimps ends ready for gluing on headers (Can be varied to use inner heads only — combination of inner and outer heads — or an outer head only). Wraps single or multiple ply including vapor seals. Unique console-control system shown will wrap paper rolls of varying sizes, one after the other in face lengths of from 7″ to 112″, and 15″ to 42″ diameters (These are not limiting dimensions). Crimper head makes hard, firm, uniform pleat for tight packaging, thereby assuring ultimate consumer of a superior product from your mill. Space-saving system includes conveyors, roll wrapping machinery, glue system, roll headers, scales, crimpers, dispensers and cutters, and lowering devices. Eliminates need for expensive trimming machines, unsightly glue pots, and other inconveniences common to normal wrapping methods.

INQUIRIES CONCERNING SPECIFIC ROLL PACKAGING NEEDS INVITED . . .

by VALLEY IRON WORKS CORPORATION
APPLETON, WISCONSIN
subsidiary of Allis-Chalmers Manufacturing Company

West Coast Representative:
E. A. Berry, P.O. Box 958, Longview, Washington
Canadian Representatives:
Pulp and Paper Mill Accessories Ltd. P.O. Box 850
Saint Laurent, Montreal 9, P.Q. Canada

VALLEY

RHOPLEX® helps packages ring up more sales

This advertisement is printed on standard bleached kraft folding boxboard. It shows how RHOPLEX coatings enhance the quality of many types of packages. The RHOPLEX binder in the coating gives the surface a smoothness and gloss comparable to high-quality printing paper. The result is vivid colors, and extremely precise halftone dot definition. This means maximum eye-catching power, maximum persuasiveness, maximum sales impact. Because RHOPLEX binders are flexible, they prevent the coating from breaking when boxboard is scored and folded.

RHOPLEX binders are chemically and mechanically stable, trouble-free and easy to use on a wide variety of paper and paperboard. Write for the technical booklet "RHOPLEX Acrylic Emulsions in Paper Coatings."

ROHM & HAAS

PHILADELPHIA 5, PA.

RHOPLEX

How RHOPLEX® all-acrylic paper coating binders improve printing properties ... make processing easier

Plus for package printing. RHOPLEX binders flow and level under the heat and pressure of the calender rolls. The result is a uniformly smooth and glossy surface. Colors are brighter, printing definition better than when natural binders are used. Ink receptivity is good, and the paper surface has controlled ink hold-out, good varnish hold-out, and very great resistance to picking. Package designers can make full use of colors, illustrations, and halftones, without being limited by the possibility of poor reproduction.

Easy application. Good results are obtained with RHOPLEX-bound coatings in a variety of different equipment. Coatings may be applied on trailing blade coaters, air knife coaters, Champion coaters, on the size press, and on the calender stack.

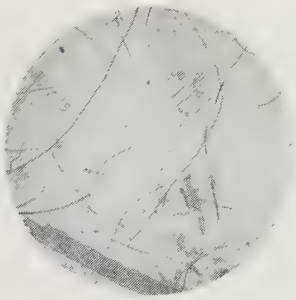
Processing advantages. Formulations using RHOPLEX as binder are chemically and mechanically stable. Coatings containing up to 65 percent solids have good working viscosity, provided the binder is mainly RHOPLEX. In many cases, total binder content of formulations can be reduced when RHOPLEX is used, since it has unusually high bonding strength. Pigmented coatings have excellent color stability. Special grease-resistant coatings for packaging and similar applications may be readily formulated with RHOPLEX binders.

Write for a free copy of the latest technical booklet on RHOPLEX paper coating binders.

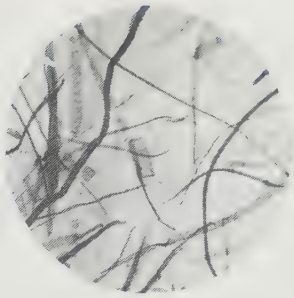
ROHM & HAAS
PHILADELPHIA 5, PA.

RHOPLEX

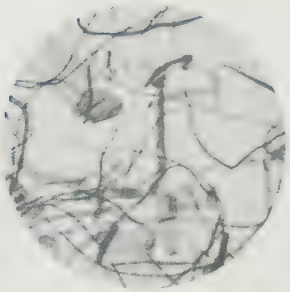
WHEAT STRAW



RICE STRAW

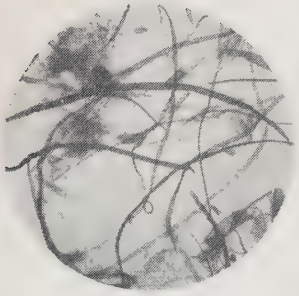


REEDS
(phragmites communis)

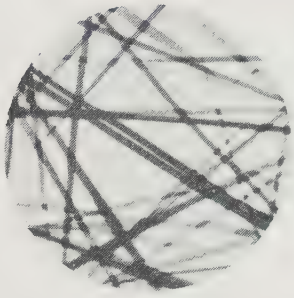


ELEPHANT GRASS
(before cleaning)

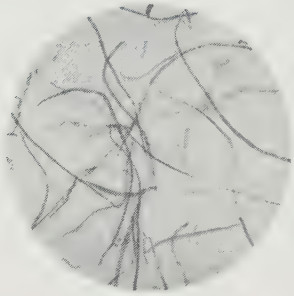
We build pulp and paper mills



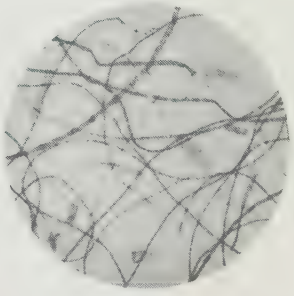
CORN STALK
(before depithing)



SUGAR CANE BAGASSE
(completely depithed)



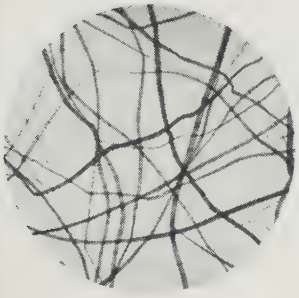
ESPARTO GRASS



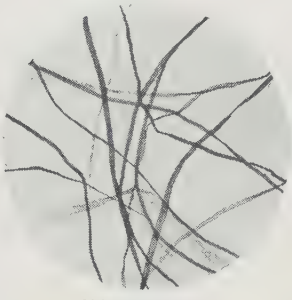
BAMBOO

around the world

magnification:
approx. 35x

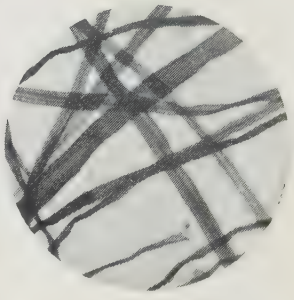


KENAF



MANILA HEMP

EUCALYPTUS SALIGNA



MONTEREY PINE

using these locally-abundant raw materials

Many countries have improved their economic position by making pulp and paper from locally-abundant grasses, woods and agricultural fibers. They began by having Parsons & Whittemore conduct a thorough technical and economic field survey. The selection of the proper process and equipment for use of such fibers is dependent upon many factors that can only be properly evaluated by highly-experienced personnel.

Field research is only one of Parsons & Whittemore's services. Our organization has world-wide technical, financial and machinery-manufacturing facilities that enable us to plan and supervise the designing, engineering, financing, construction and equipment of pulp and paper mills in any country having the required raw materials. We will even train local workers to operate the mill...and our branch offices will arrange for the sale of the plant's pulp and paper output on world markets. For information on any or all of these services, write to our nearest office.

THE PARSONS & WHITTEMORE / LYDDON ORGANIZATION

World leaders in the development of pulp and paper mills for the use of local fibers

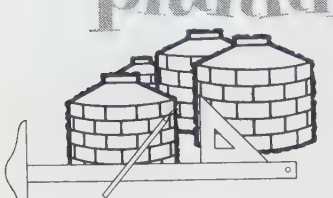
18-19 Savile Row, London W.1, England

5 Rue Jean Mermoz, Paris 8°, France

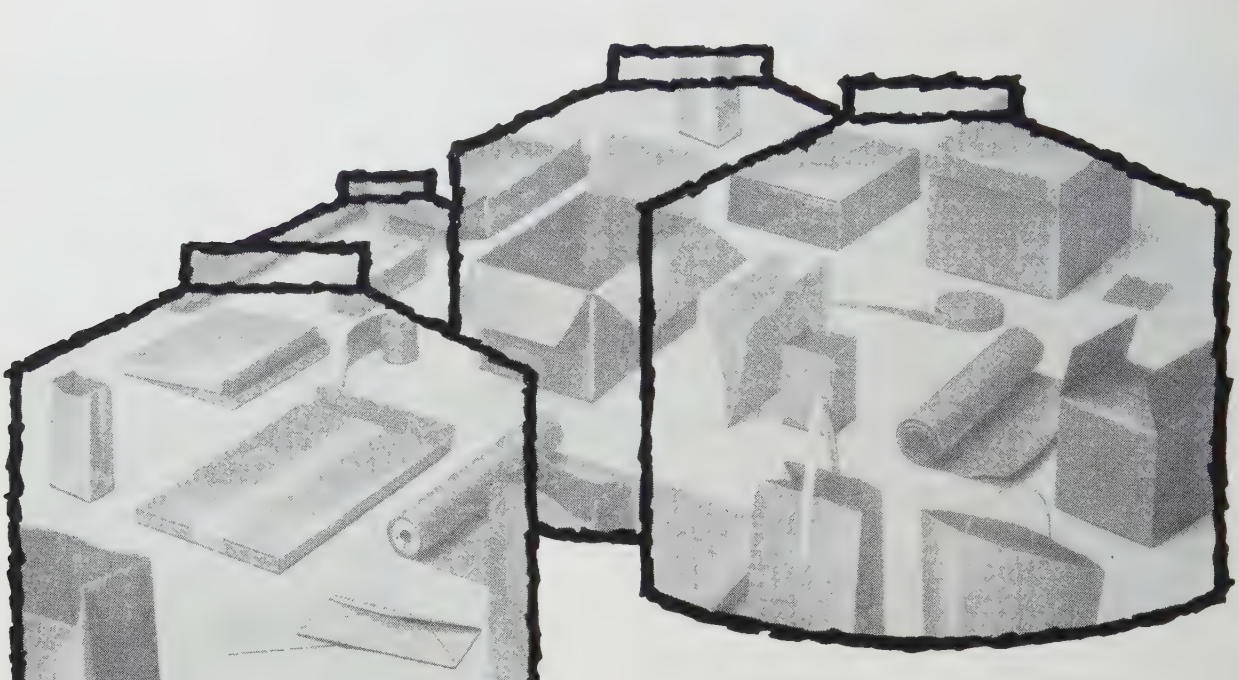
250 Park Avenue, New York 17, N.Y.

WEST END

advance planning



OF ENLARGED SALT CAKE STORAGE ANTICIPATES INDUSTRY'S GROWING NEEDS



WEST END as a major supplier of highest quality natural salt cake programs expansion of its in-plant storage to meet ever-increasing requirements of industry. West End is constantly exploring new solutions to transportation, distribution and handling problems to assure its continuing position as a reliable and economical source.

Stauffer CHEMICALS

WEST END CHEMICAL COMPANY • DIVISION OF STAUFFER CHEMICAL COMPANY

636 CALIFORNIA STREET, SAN FRANCISCO, CALIFORNIA • PLANT: WESTEND, CALIFORNIA

Quality YOU CAN SEE...

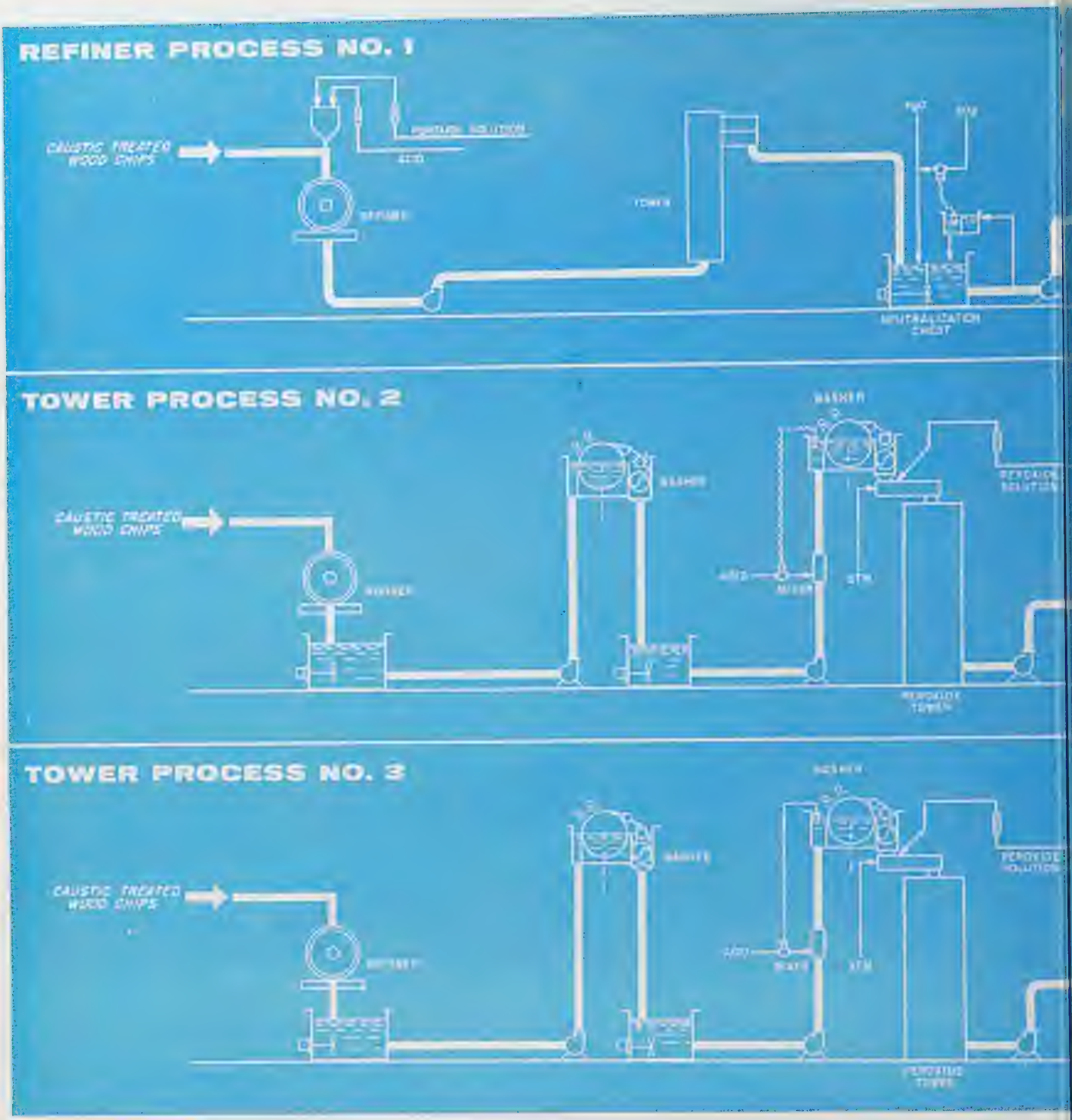
When you look through a speeding roll of carbon paper, the slightest defect in the wax used will show up quickly. Wax, the vehicle for the ink, is the essential ingredient in the ultra-thin carbon paper made by the Kling Manufacturing Company, of Chicago. Their customers, manufacturers of "unit sets," insist on high quality.

Eight years ago Kling chose Cities Service Pacemaker 53 Wax. Because they compete with larger national companies, they must offer their customers superior quality and fast service. "You can see," says Plant Superintendent Frank Orlow, "that our quality control is a direct result of the wax we use."

If you want to see a quality wax in action, try Pacemaker 53 Wax. Call your nearest Cities Service office or write: Cities Service Oil Company, 60 Wall Street, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS


REFINER PROCESS NO. 1
CAUSTIC TREATED WOOD CHIPS
TOWER PROCESS NO. 2
CAUSTIC TREATED WOOD CHIPS
TOWER PROCESS NO. 3
CAUSTIC TREATED WOOD CHIPS

Which process is best for

experience can help you make the right

...and save you thousands of dollars in

CALL ONE OF THESE MEN... LET HIM WORK WITH YOU IN MAKING THIS IMPORTANT DECISION:

Blueprints for Better Bleaching

Du Pont experience has helped many mills make the right choice between tower or refiner bleaching for cold caustic pulp based on brightness requirements. For example:

60 brightness. In process No. 1 at left, caustic-treated wood chips enter refiner and are bleached with "Albone" hydrogen peroxide and acid*. The use of acid controls the alkalinity of the bleaching reaction and assures maximum response from the hydrogen peroxide. Sulfur dioxide (SO_2) then neutralizes the bleached pulp and stabilizes the brightness obtained in the refiner. **Du Pont Patent Pending.*

65 to 75 brightness. In process No. 2 at left, pulp is refined, washed to remove caustic solubles, acidified with sulfuric acid to remove acid solubles, washed, and bleached in a conventional peroxide tower to desired brightness in the 65 to 75 range.

70 to 80 brightness. In process No. 3 at left, pulp goes through the same steps as in process No. 2. Then pulp is neutralized, and bleaching is completed in a hydrosulfite tower for maximum brightness in the 70 to 80 range.

Electrochemicals Department, Peroxygen Products Division
Wilmington 98, Delaware

ALBONE® hydrogen peroxide — DU PONT — **SOLOZONE®** sodium peroxide

BETTER THINGS FOR BETTER LIVING...*THROUGH CHEMISTRY*

bleaching cold caustic pulp? Du Pont choice between tower or refiner bleaching investment and chemical costs.

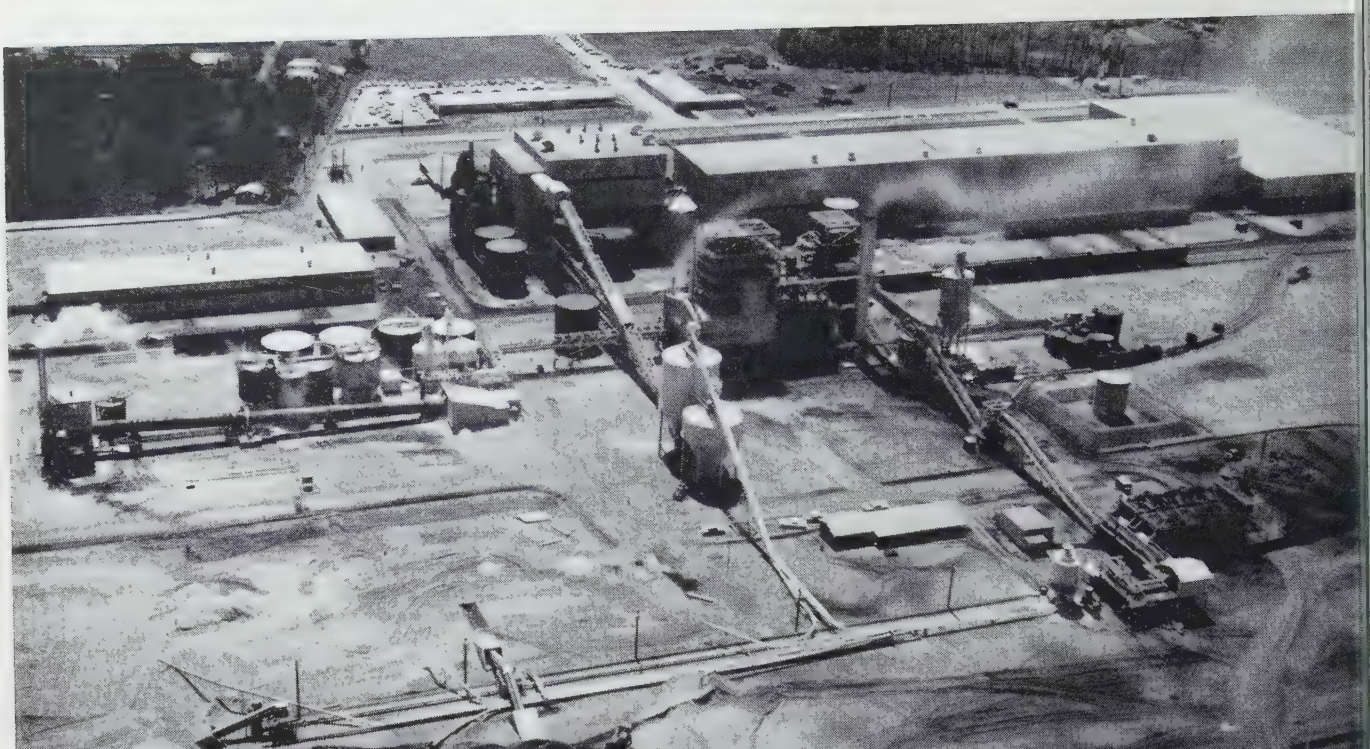
Midwest Area
W. L. Liike, Chicago, Ill.—INdependence 3-7250

New York & Boston Area
C. R. Lombard, New York, N. Y.—LOngacre 3-6440

West Coast Area
P. E. Kiefer, Portland, Oregon—CApital 7-1281

Southern Area
R. W. Hammond, Charlotte, N. C.—FRanklin 5-5561

Or call: A. T. Hawkinson, Wilmington, Delaware—PRospect 4-4698

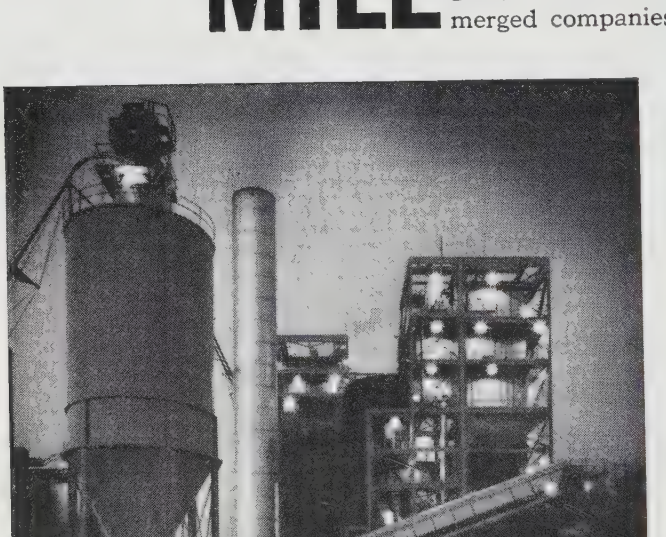


The new Tennessee River Mill, near Counce, Tenn. Note outdoor-type C-E boilers (upper center). The mill was engineered and constructed by The M. W. Kellogg Company. H. A. Simons (International) Ltd., consultants.

C-E provides all steam for new, record-breaking

TENNESSEE RIVER MILL

Record-breaking in many ways, Tennessee River Pulp and Paper Co.'s new 500 ton/day kraft linerboard mill has one of the most ideal locations in the U.S.—near abundant supplies of water, pine and hardwood and a natural gas pipe line. The mill's recovery and bark-power boilers are the first in the industry to employ full outdoor construction. • In keeping with their high engineering standards, the mill owners (a group formed of Packaging Corporation of America representing three merged companies, Bell Fibre Products Corp. and St. Regis Paper Co.) turned to Combustion Engineering for advanced-design steam generating equipment. This consists of a chemical recovery unit designed to burn 1,250,000 lb of dry solids a day, and a 300,000 lb/hr steam generator burning bark, gas and oil (with provision for future pulverized coal firing). Units operate at 600 psi and 750F. • C-E has long been a leading supplier of boilers for the paper industry—was the first to break the recovery unit "capacity barrier" and exceed 500 tons in capacity (an 800 ton C-E unit is now on order). For information on boiler designs for any pressure, temperature or capacity—for any fuel or combination of fuels...call your local C-E office or write the Paper Mill Division in Windsor. • ***Ask for the new catalog "C-E Equipment for the Pulp and Paper Industry."***



Night View of C-E boilers—recovery unit at the left, bark burner at the right.

COMBUSTION ENGINEERING C-E

C-339

General Offices: Windsor, Conn.
New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIP

for paper and board coating save with high-fluidity Penford Gums

the new high-fluidity Penford Gums replace synthetic latices in high-solids pigmented coatings. Their fluidity plus other traits make these hydroxy ethyl ether derivatives suitable for use as the sole adhesive in some pigmented coatings and in combination with latices in other cases. Coatings so made have low stable viscosity, high gloss and excellent ink receptivity.

The new high-fluidity Penford Gums are available in two groups: the 2000 and 3000 series. Both groups offer a wide range of viscosity. Use the coupon to request additional information and formulas.

Penick & Ford

PENICK & FORD, LTD.

INCORPORATED

750 THIRD AVENUE, NEW YORK 17, N. Y.
1531 MARIETTA BLVD., ATLANTA, GA.
CEDAR RAPIDS, IOWA
333 MARKET ST., SAN FRANCISCO 5, CALIF.

PENICK & FORD, LTD., INC. • 750 THIRD AVENUE, NEW YORK 17, N. Y.

Please send me data on the new high-fluidity Penford Gums (2000 and 3000 series) for use in connection with .....

.....

Name .....

Title .....

Company .....

Street .....

City ..... State .....

wet rub resistance

U. F. Concentrate-85 boosts wet rub resistance and printability of starch-clay coati

U.F. Concentrate contains 85% active ingredients — 60% formaldehyde and 25% urea, by weight. Combining U.F.-85 with starch enables you to produce coated papers with increased printability, better wet rub resistance at lower cost. ■ Moreover, the preservative action of the contained formaldehyde in U.F. Concentrate-85 retards starch deterioration, sharply reduces unpleasant odors common in hot weather. ■ Allied Chemical has article reprints and a 36-page brochure on U.F.-85 giving specifics on its uses in paper coating. Just write, or call — HA 2-7300 (N.Y.C.) ■ specifications and local offices, see our insert in Chemical Mat Catalog, pages 475-482 and in Chemical Week Buyers G pages 37-44.

Allied Chemical

BASIC TO AMERICA'S PROGRESS

NITROGEN DIVISION

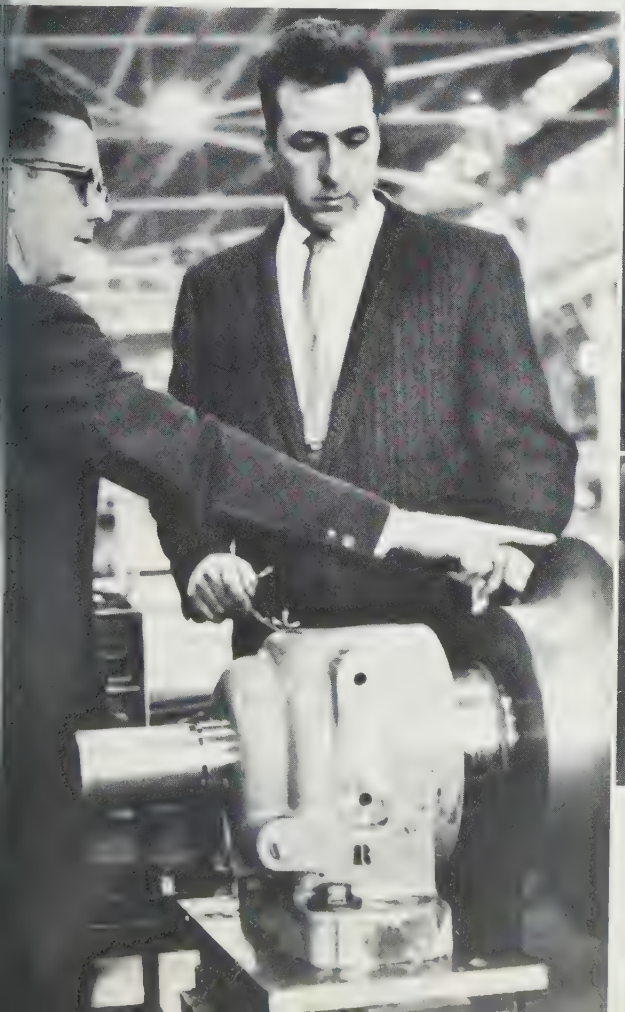
Dept. UF 10-28-1, 40 Rector St., New York 6, N. Y.

FINISHED PRODUCT PROCESSING EQUIPMENT Winders • Reclaim Winders • Cutters • Slitters • Sheeter • [illegible] • [illegible]
Tables • Roll and Shaft Handling Equipment • Conveyors • Unwind Stands and Tru Tension Controls • and other equipment for the [illegible]

before you decide on a new **flying splicer**

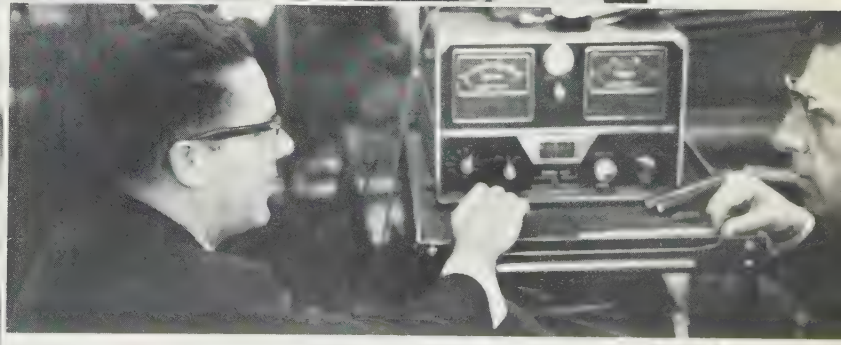
meet some "Beloit Eastern" people

PRECISION OF MANUFACTURED PRODUCT gets expert attention from John Okas, manager of manufacturing service *(left, below)*, and sales representative Carson Cash. Winder drum of "flying splicer" (continuous unwind) is here being checked out on electronic balancing machine.



OKAS brings new methods, extens v manufacturing know how to all stages o engineering.

CASH applies exten sive experience to ex acting problems o finishing and convert ing n customer mills.



BELOIT EASTERN PAPER MACHINERY DOWNINGTOWN, PENNA.

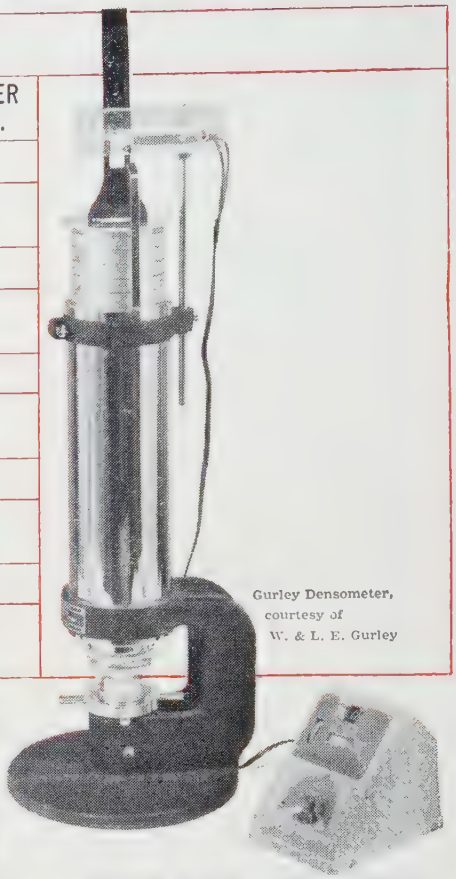
Member Beloit Group

BELOIT EASTERN
CORPORATION
Downingtown, Pennsylvania

Actual mill runs prove

KELGINS® and KELSIZE S®

ACTUAL MILL RUNS			
MILL	SIZE AND BASIS WEIGHT	SURFACE SIZE FORMULA	GURLEY DENSOMETER SECONDS/100 C.C.
A	BLEACHED BOARDS	CONTROL (USUAL FORMULA)	150
		CONTROL PLUS 0.3% KELGIN	3000—5000
B	17 x 22—11 LBS.	CONTROL (USUAL FORMULA)	14
		CONTROL PLUS 0.2% KELSIZE S	28
C	34 x 22—14 LBS.	CONTROL (USUAL FORMULA)	17
		CONTROL PLUS 1.0% KELGIN XL	59
D	17 x 22—25 LBS.	CONTROL (USUAL FORMULA)	26
		CONTROL PLUS 0.3% KELGIN LV	40
E	34 x 22—32 LBS.	CONTROL (USUAL FORMULA)	400
		CONTROL PLUS 1.5% KELGIN XL	1800



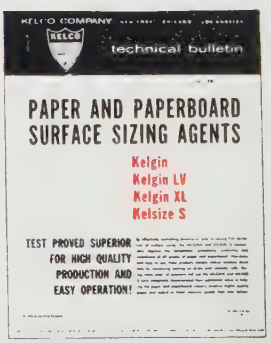
Gurley Densometer, courtesy of W. & L. E. Gurley

INCREASE DENSOMETER TEST

Unmatched, this unique ability of the Kelgins and Kelsize S to raise densometer test. With stock refining reduced, you achieve far higher machine speeds and increased production. Applied at size press as the sole sizing agent or with other sizing, the Kelgins and Kelsize S effectively close up the sheet, substantially raise densometer. Solution make-up is remarkably quick and easy, for the Kelgins and Kelsize S dissolve fast and completely in cold or hot water. Completely non-tacky, the Kelgins and Kelsize S appreciably improve machine speeds and substantially reduce "set-asides".

YOURS ON REQUEST:

Technical Bulletin details latest data on Kelco surface sizing agents including specific solutions to problems of improving densometer, printability, uniformity, smoothness, reduction or machine down time.



KELSIZE S® KELGIN® KELGIN LV KELGIN XL
products of KELCO COMPANY

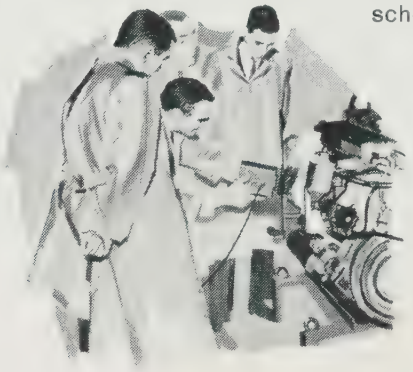
75 Terminal Avenue, Clark, N.J. 20 N. Wacker Drive, Chicago 6, Ill. 530 West Sixth Street, Los Angeles 14, Calif. Cable Address KELCOALGIN-Clark, New Jersey.

This is AMERICAN OIL COMPANY

Our organization has more than 70 years' experience in the oil business. We are one of the largest petroleum organizations in America.

We believe the experienced American Oil representative who calls on you, plus the waxes, the petroleum products and the facilities which he has at his disposal, are reasons why you will like to do business with us.

Your American Oil representative receives special training for his job at our Sales Engineering School. He is given concentrated basic instruction in all phases of petroleum product quality and application—including waxes. According to a planned schedule, he returns for an advanced course and then again for post-graduate work.

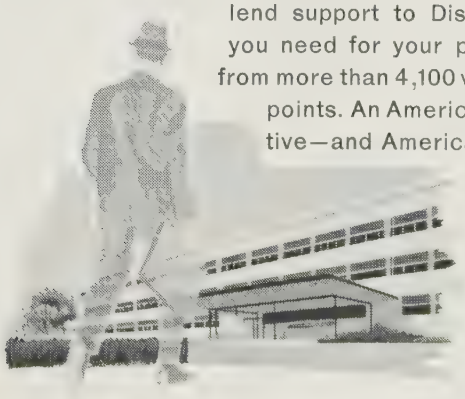


In our Marketing Technical Service Department are specialists who are recognized authorities in their fields. These senior consultants may be called in to work with you on any specialized wax application or lubrication problems.

More than 1,000 research scientists and technicians are at work in our research laboratories developing new products and finding ways to improve present products. Their mission: To help your American Oil representative help you lower your maintenance costs and stretch your maintenance dollars.

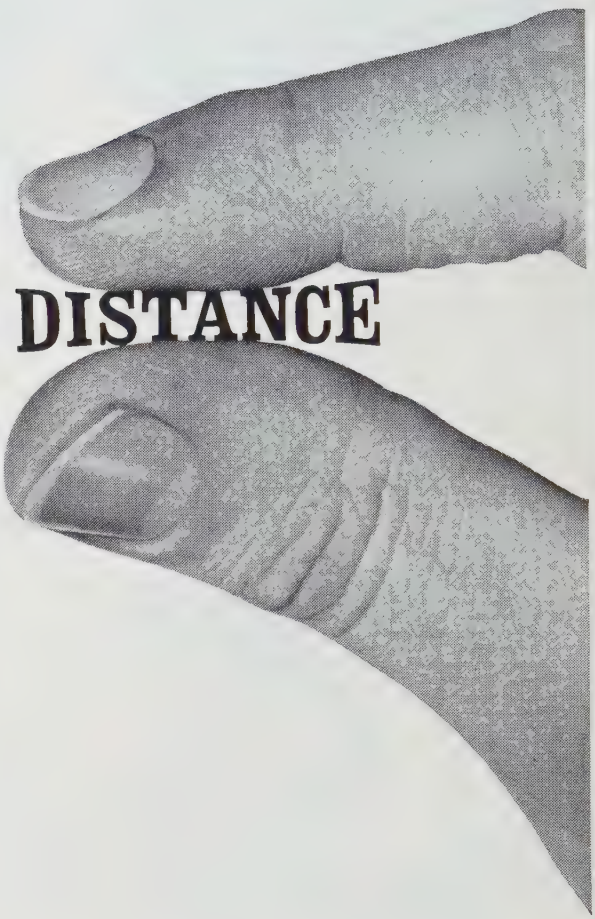
Twelve American Oil refineries give flexibility to the production of petroleum products and waxes for industry. They help make it possible to assure prompt delivery.

American Oil representatives operate from 74 District Offices. Thirteen Regional Offices strategically located throughout the country lend support to District Offices. The products you need for your plant or fleet are available from more than 4,100 warehouses and distribution points. An American Oil Company representative—and American Oil products—are only a telephone call away. We invite you to make that phone call. Or write **American Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.**



AMERICAN

AMERICAN OIL COMPANY



MATHIESON SQUEEZES DISTANCE

...to cut your caustic delivery time

Order caustic soda from Mathieson and watch the miles shrink! Mathieson delivery makes distances seem shorter because you get caustic soda into your plant quickly and on schedule. Eight producing plants and shipping points (and a ninth under construction) cover the industrial East.

There are reasons, too, why Mathieson lowers delivery costs. Only Mathieson ships 73% caustic by truck for fewer trips, less weight, lower freight and faster hauls.

And, of course, Mathieson service backs every order with technical assistance—on the spot or laboratory-checked. For full details, write OLIN MATHIESON, Baltimore 3, Maryland.

Ammonia • Sodium Bicarbonate • Carbon Dioxide • Caustic Soda • Chlorine • Hydrazine and Derivatives • Hypochlorite Products • Methanol • Muriatic Acid • Sodium Nitrate • Nitric Acid • Soda Ash • Sodium Chlorate • Sodium Chlorite Products • Sodium Methylate • Sulfur (Processed) • Sulfuric Acid • Urea 276

CHEMICALS DIVISION Olin

anyone for lunch?

Should your paper mill "menu" offer sugar . . . gum . . . amino acid . . . casein . . . glue . . . you can be sure that such slime-causing eager-eaters as *Bacillus megatherium* or *Bacillus subtilus* are just waiting to move right in and cause a whole host of problems.

But you can do something about it *now* to head off or control existing slime problems through the use of an *effectively* planned program of microbiological control . . . *ONE* of the many services offered by Betz Laboratories. For over 35 years, Betz has provided a specialized consulting engineering service to the paper industry, including the use and application of slime control agents, pitch dispersers, anti-scaling agents, retention aids, filming amines, corrosion inhibitors, and deinker aids.

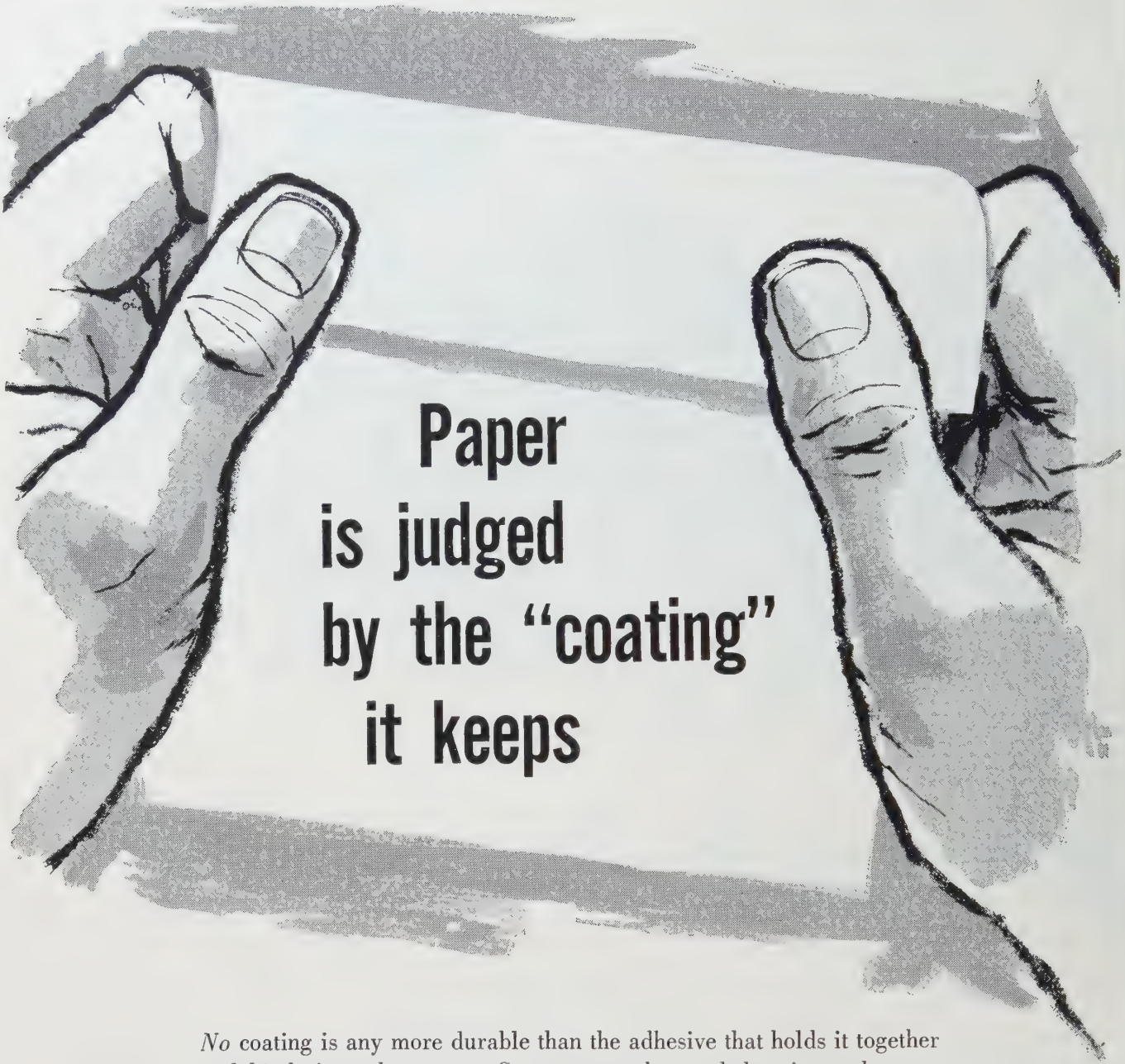
Bulletin 592 discusses the Betz *specialized* approach to microbiological control. Write for a copy, there's no obligation.

Betz Laboratories, Inc., Philadelphia 24, Pa.
Betz Laboratories Ltd., Lachine (Montreal), Canada

BETZ

CONSULTANTS ON MICROBIOLOGICAL CONTROL

Printed in U.S.A.



Paper is judged by the "coating" it keeps

No coating is any more durable than the adhesive that holds it together and binds it to the paper. CLINTON starches and dextrins make sure that your coated stock has a uniform finish free from "skips." Used as a clay coating or as a size, CLINEO starches add a high degree of strength and gloss printing quality to gloss surfaces. CLINCAL starches — containing their own lubricants — improve printability and control curl. Both starches are available in many varieties. For quality that makes a lasting impression on customers and prospects, use CLINTON coating starches.

Technical service always available

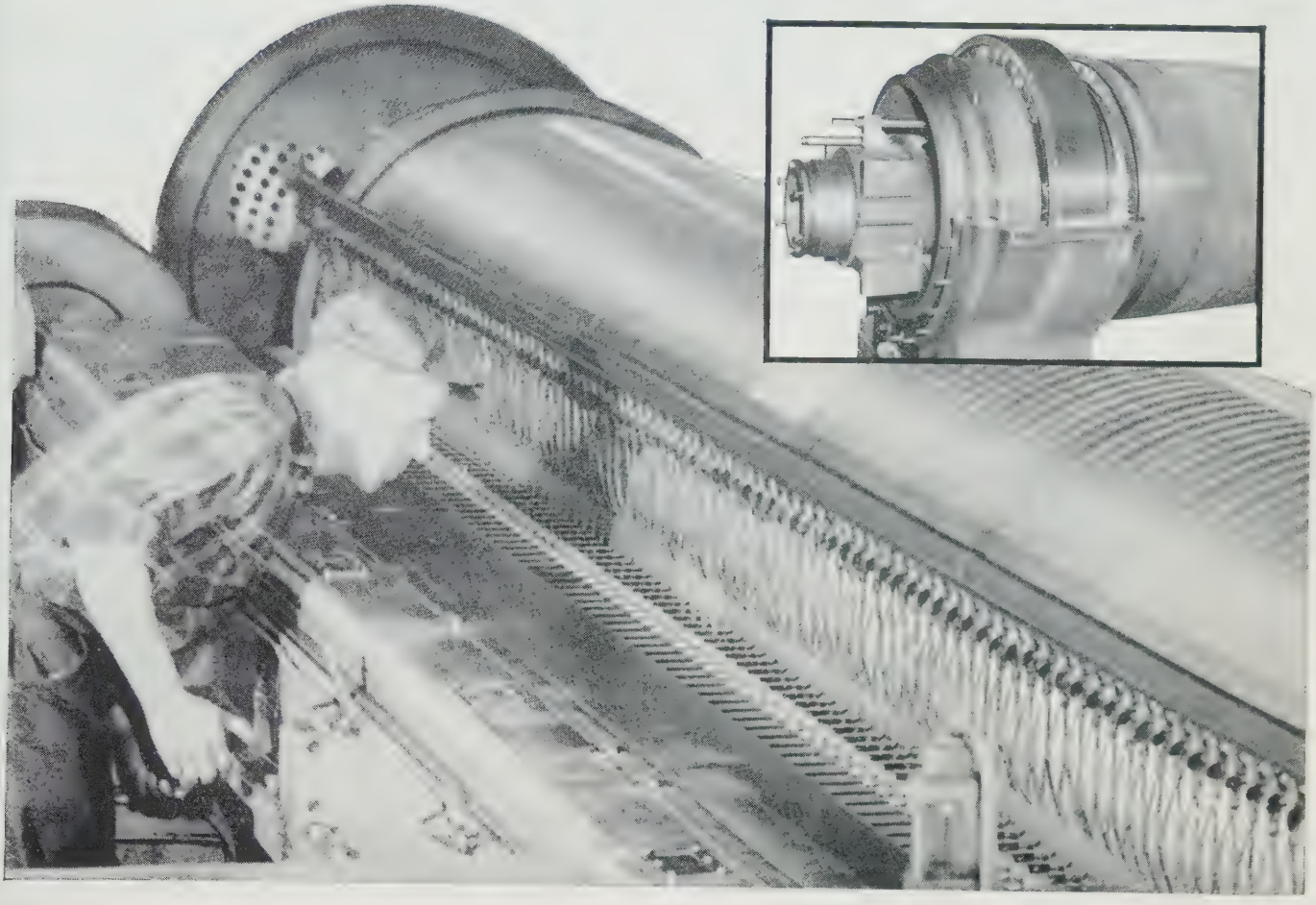
CLINTON CORN PROCESSING COMPANY

CLINTON

CLINTON, IOWA

Over 100 installations in Canada prove:

MORE EFFICIENT WATER REMOVAL and LONGER FELT LIFE with DOMINION STAINLESS STEEL SUCTION PRESS ROLLS



This proven operating superiority of Dominion rolls is the result of these design and construction features:

DESIGN

★ Open-end design for maximum accessibility and easy inspection.

★ Air-loaded suction box tops to ensure uniform wear of deckles and minimum adjustment.

★ Silent drilling pattern for quieter operation.

CONSTRUCTION

★ Forged stainless steel shell for maximum strength, to permit higher line pressures and ensure longer felt life.

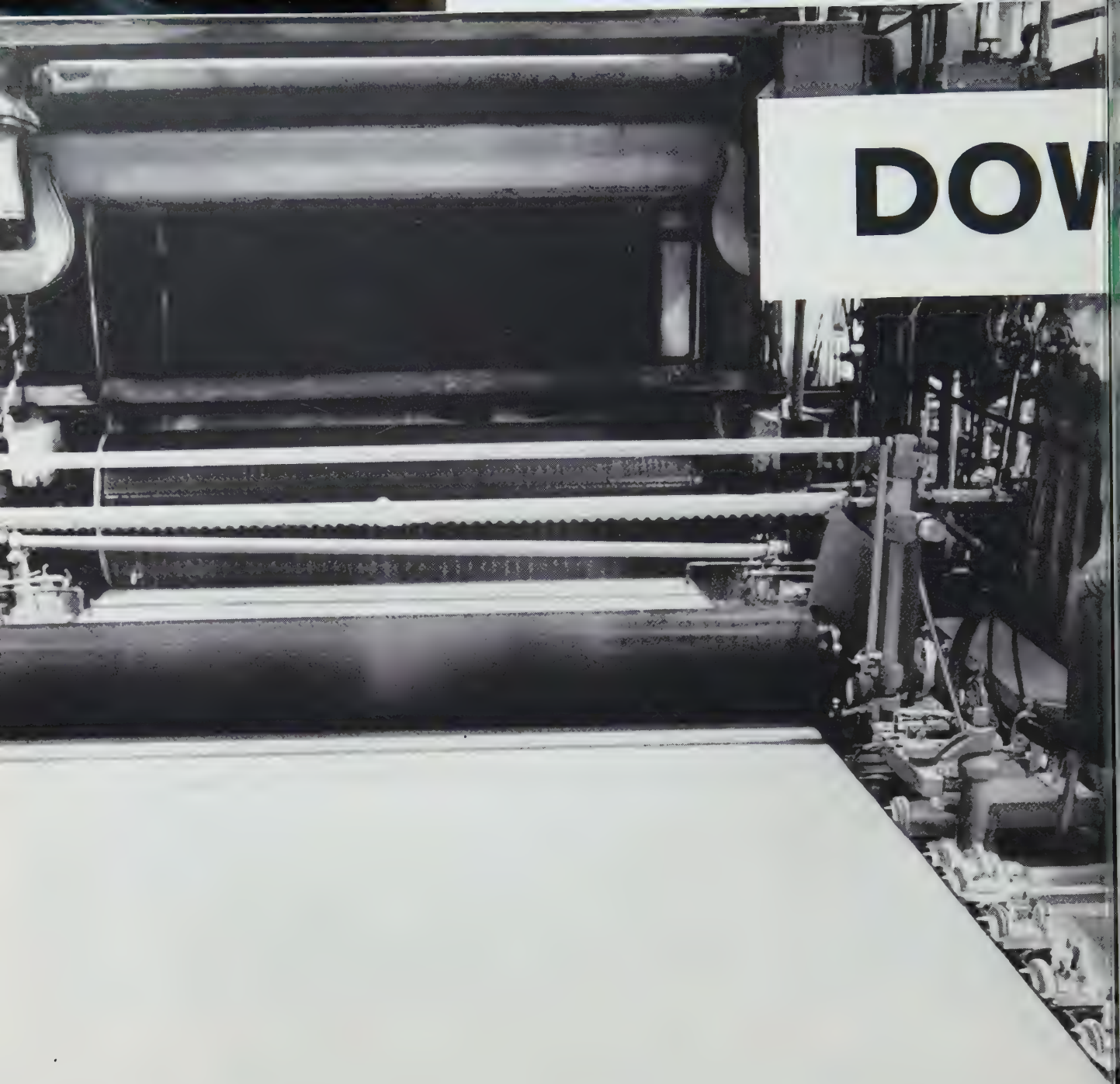
★ Suction connection located either front or rear; easy removal of suction boxes without removing head.

★ Large anti-friction bearings for long life, low maintenance.

★ Adjustable suction box widths.

Dominion Suction Couch Rolls offer all the features listed here. They are normally supplied with a centrifugally cast bronze shell; in certain cases, stainless steel is used to overcome corrosion problems.

FOR FULL DETAILS, PLEASE CONTACT
PAPER DIVISION
DOMINION ENGINEERING
COMPANY LIMITED
Montreal
Toronto
Vancouver



Trial runs can be set up in your plant by Dow technical personnel. For full details, just call your nearest Dow sales office.

paper processing chemicals

SEPARAN POLYMERS

INCREASED RETENTION WITH SEPARAN SAVES $2 TO $15 PER TON IN FILLER COSTS

SEPARAN® NP10 shows a remarkable ability to attach pigments and fillers to cellulose fibers. Applying this property to paper making has resulted in substantial increases in filler retention with savings in valuable pigment and filler costs.

The chart shows typical improvements with several sheet types. The net savings were calculated by subtracting the cost of the Separan NP10 used from the value of the filler saved.

Improved retention decreases the save-all load, headbox consistency, two sidedness, pinholes, wire abrasion and felt plugging. Hence, it contributes to improved formation and better machine operation.

Process water treatment is another area where Separan products can improve operations. Although Separan does not replace primary flocculants such as alum, it does reduce the amount needed. Separan NP10 does, however, act as a secondary coagulant which improves settling rates and clarity in primary water treatment.

Separan products are high molecular weight, water soluble polymers. Solutions can be easily prepared and handled.

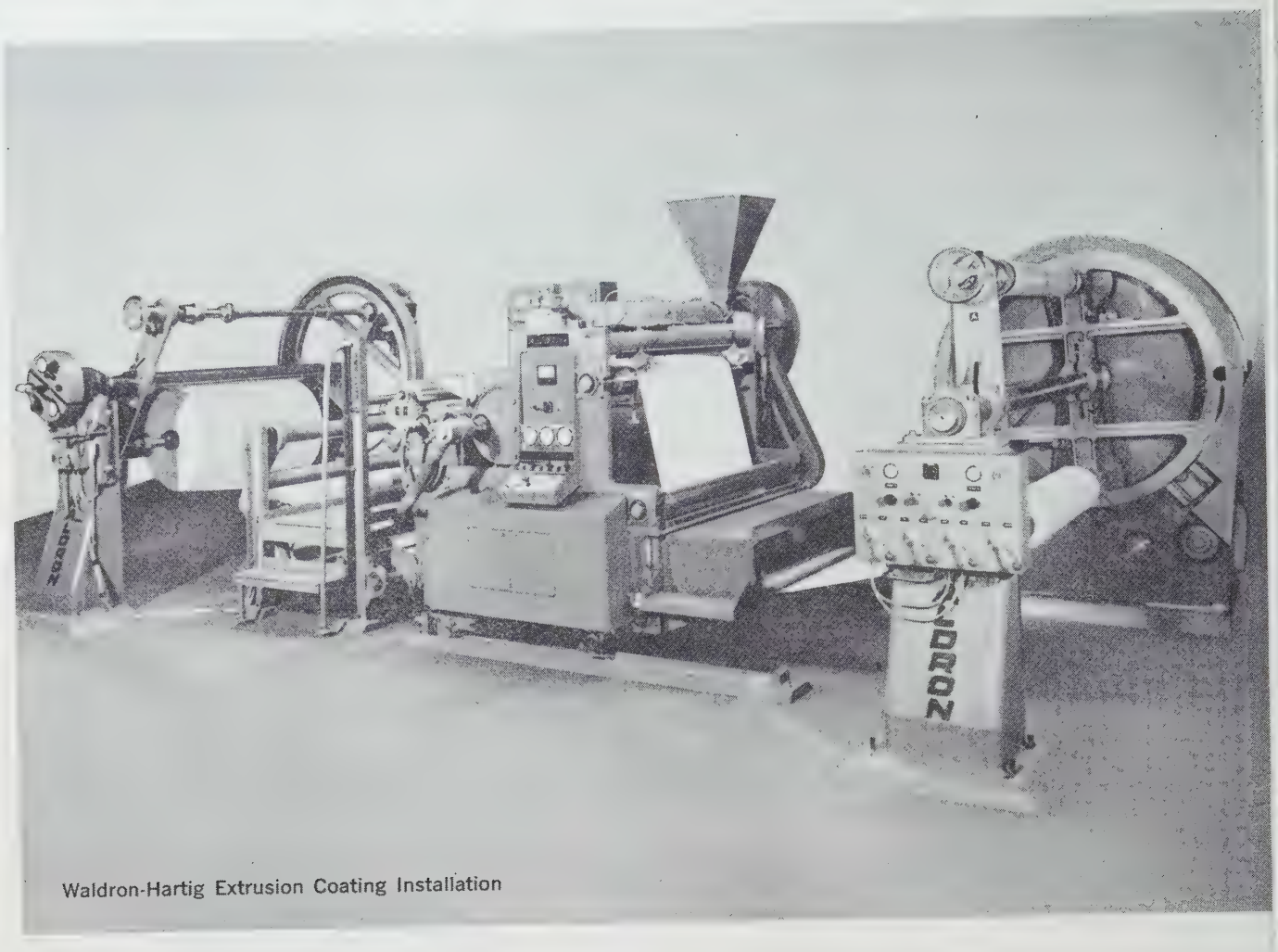
If you are not already using Separan, make an appointment for a trial run in your own plant with technical assistance from Dow. They will furnish proportioning pumps to make the trials convenient and consistent with your present operation. Just call your nearest Dow sales office.

Latest Mill Results	SEPARAN NP10 lb. / ton	CLAY lb. / ton	TiO_2 lb. / ton	ASH %	OPACITY %	NET SAVINGS $ / ton WITH SEPARAN NP10
55 lb. ENVELOPE	NONE	550	0	7.3	88.0	
	0.5	310	0	10.3	90.2	$4.30
30 lb. MAGAZINE	NONE	600	0	14.8	74.0	
	0.4	375	0	14.1	74.0	$4.10
60 lb. OFFSET BOND	NONE	550	30	12.2	92.0	
	0.5	400	30	13.7	92.0	$2.50
25 lb. MACHINE COATED CARTON WRAP	NONE	50	150	12.2	77.0	
	0.75	50	125	13.2	76.0	$5.50
50 lb. OFFSET BOND	NONE	370	145	9.6	89.0	
	0.6	145	100	12.6	90.5	$15.15

THIRTEEN LOCATIONS COUNTRY-WIDE ASSURE PROMPT DELIVERY OF DOW CAUSTIC SODA

To serve you better, Dow Caustic Soda Solution 50% is available when, where, and how you want it from thirteen shipping points throughout the country. Fast delivery is assured via tank car and tank truck from four producing plants—Midland, Mich.; Freeport, Texas; Plaquemine, La.; and Pittsburg, Calif.; plus nine terminals—N. Charleston, S. C.; Carteret and Bayonne, N. J.; Denver, Colo.; Grants, N. Mex.; Chicago, Ill.; Los Angeles, Calif.; St. Louis, Mo., and Baltimore, Md. All provide tank truck and tank car shipments. For more information, call your nearest Dow Sales Office or write THE DOW CHEMICAL COMPANY, Midland, Michigan.

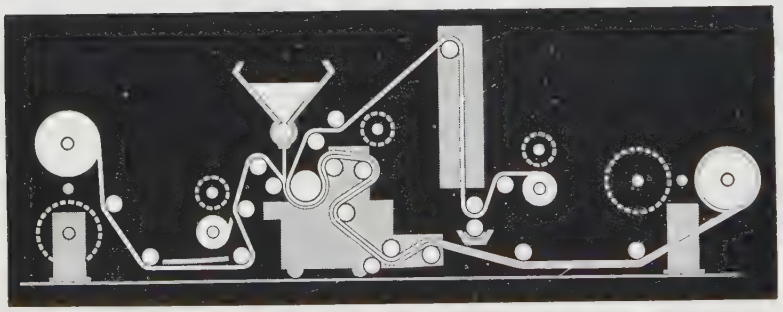
THE DOW CHEMICAL COMPANY DOW Midland, Michigan



Waldron-Hartig Extrusion Coating Installation

Integrated web process systems

for Coating, Laminating & Casting



A complete line of standard unwinds, winds, coaters, laminators, embossers, extruders and ovens are especially combined for your converting process needs—proven units of the latest design!

Waldron-Hartig provides complete project responsibility. Qualified representatives are available to discuss your needs. Write for information.

WALDRON-HARTIG

technical competence in web process machinery

WALDRON-HARTIG, Box 791, New Brunswick, N. J./a division of Midland-Ross Corporation

The Mechanism of Acid Bisulfite Pulping

II. Process Problems in Continuous Operations

W. J. NOLAN

A preliminary survey was made of some of the problems that will be encountered in continuous acid bisulfite pulping. According to present theory, which requires that a warm-up period for liquor penetration is necessary to prevent "burning," cooking at a constant elevated temperature would not be possible. Such a condition is necessary for high-speed continuous cooking. Using NH_3 base, spruce wood, a combined SO_2 of 1.0% and an initial total SO_2 of 5.0 to 6.0%, satisfactory cooks were obtained at 148° C., using preheated liquor and a preheated digester to achieve the constant temperature with virtually no warm-up period. Shredded wood was necessary under the chosen conditions. Ordinary mill chips required too long a cook and showed signs of incipient burning before a reasonable screened yield was obtained. No attempt was made to optimize the cooking conditions. A method is given for calculating the actual SO_2 concentration with allowances for liquor decomposition and relief. A method is presented for predicting total pressure, using published literature data at low temperature. A brief discussion is given of corrosion and material problems.

THIS RESEARCH was undertaken as an exploratory program with three ends in view: (1) to prove that acid bisulfite cooking can be carried out at constant, elevated temperatures—a prerequisite of high speed, continuous operation; (2) to obtain an estimate of the scope of future research which must be undertaken before the optimum operating variables of the process can be evaluated; (3) to acquire knowledge of mechanical and chemical difficulties which will be involved in continuous operation. It is not possible, with our present knowledge of the pulping variables, to define the optimum operating conditions for producing pulps comparable to those made by existing batch methods.

It is first necessary to prove that constant temperature operations can be used to make satisfactory pulps because it has long been accepted as fact that several hours must be allowed for the wood chips and acid bisulfite liquor to reach maximum cooking temperature. The theory behind this belief states that gaseous sulfur dioxide will penetrate rapidly into the wood chips. This sulfur dioxide, combining with the moisture in the wood, will create a highly acidic condition which will, at elevated temperatures, cause a condensation of the lignin or "burning." Therefore, according to the theory, sufficient time at low temperature must be provided so that the acid bisulfite salt of NH_3, Na, Ca or Mg, whichever base is used, can penetrate into the wood to buffer the acidity of the H_2SO_3.

If this theory is correct and constant temperature operations are to be undertaken, it becomes necessary to prepenetrate the wood chips with both acid and bisulfite before the chips are introduced into the digester. Therefore, as a starting point toward continuous pulping, it must be determined whether this prepenetration with liquor is essential.

The presence of sulfur dioxide in the gas phase as well as in the liquid phase makes acid bisulfite pulping much more complicated than either the kraft or neutral sulfite system when one considers high speed, continuous operation. For an economic design of a continuous digester the pulping variables, temperature and chemical concentration particularly, should be so adjusted that retention time in the digester is 60 min. or less. High values of either or both of these variables can lead to unusually high digester pressures and to even more corrosive conditions than are now encountered. High temperatures will also increase the velocity of the autoxidation–reduction reaction, first reported for cooking liquors by Marusawa (*1*), whereby sulfur dioxide is converted to sulfur trioxide and sulfur. This reaction not only robs the system of HSO_3^- ions (the lignin sulfonating agent) but it also decreases the pH of the solution because of the highly ionized H_2SO_4 formed.

These are only a few of the actual complications which may develop when one tries to convert from the slow, batch methods as presently practiced to the relatively rapid reactions involved in constant temperature, continuous methods. However, the advantages accruing from a continuous system, such as uniformity of product, increased economy of operation and, possibly, more efficient wood utilization, instigated the exploratory investigation under discussion and should make a sizable investment in future research worthwhile.

APPARATUS AND PROCEDURE

The experimental digesters used to carry out constant-temperature pulping have been previously described (*2*). To prevent sulfur dioxide leakage during the cook, minor construction changes were made, such as replacing all threaded connections with welded joints and the use of Teflon-lined plug valves instead of gate valves. A cyclone blow pit, discharging the pulp directly into canvas bags, was also used.

For constant-temperature pulping it was necessary to preheat both digesters and cooking liquor before charging. Hot liquor was stored in a type 316 stainless steel tank, 24 in. diam. by 52 in. in length. An inclined tube, natural circulation heat exchanger was mounted under the tank and connected to it. This heat exchanger was used to preheat the cooking liquor in order to keep the contact time between liquor and the hot steam tube surface at a minimum, since the autoxidation–reduction of sulfur dioxide to sulfur trioxide and sulfur accelerates with increased temperature. About 120 min. were required to bring the liquor

W. J. NOLAN, Professor in Charge, Pulp and Paper Laboratory, Engineering and Industrial Experiment Station, University of Florida, Gainesville, Fla.

Table I. Constant-Temperature Pulping of Spruce by the Ammonium Acid Bisulfite Process
7.0 liters of liquor used per 1000 g. of O.D. wood, cooking temperature 148°C., 50 p.s.i. steam

Cook no.	Cooking time, min.	Max. total press., p.s.i.	Per cent SO_2 in cooking liquor: Total	Combined	Color of waste liquid	Yield, O. D. wood, %: Total	Screened	Screenings, total yield, %	Lignin in pulp, %	D.P. of pulp lignin-free
Mill-size chips—unimpregnated										
3193	45	130	3.3	1.0	...	69.6	...	100	...	...
3194	90	116	3.3	1.0	...	64.0	7.4	88.4	16.1	...
3195	135	114	3.3	1.0	Dark orange	57.1	18.3	67.9	7.2	1688
3196	180	112	3.3	1.0	Brown-red	53.8	20.2	62.5	4.6	1435
3197	225	110	3.3	1.0	Brown	50.2	22.1	56.1	2.4	1067
3198	270	112	3.3	1.0	Black	46.7	23.7	49.3	2.5	744
3199	45	110	3.4	1.2	...	72.3	...	100	...	...
3200	90	111	3.4	1.2	Yellow	64.4	6.5	89.9	15.2	...
3201	135	113	3.4	1.2	Light orange	58.6	17.4	70.2	9.8	1807
3202	180	115	3.4	1.2	Orange red	54.9	21.0	61.7	6.8	1687
3203	225	114	3.4	1.2	Brown-red	50.6	27.0	46.7	3.6	1536
3204	270	111	3.4	1.2	Licorice brown	50.7	27.4	45.9	1.8	1189
Mill-size chips—vacuum pre-impregnated with cooking liquor (SO_2: 5.6% total, 1.3% combined)										
3211	30	107	3.4	1.3	...	...	...	...	...	...
3212	60	102	3.4	1.3	Yellow	...	...	...	...	...
3213	90	110	3.4	1.3	Yellow	66.0	3.6	94.5	16.0	...
3214	120	112	3.4	1.3	Orange-yellow	60.7	20.6	66.0	12.2	1920
3215	150	121	3.4	1.3	Orange	56.9	31.9	44.0	9.5	1854
3216	180	...	3.4	1.3	Red-orange	54.3	35.0	35.6	6.7	1795
Shredded chips—unimpregnated										
3175	20	109	3.7	1.2	Yellow	83.3	...	100	...	...
3176	40	104	3.7	1.2	Yellow	74.4	...	100	...	...
3177	60	107	3.7	1.2	Yellow	69.7	...	100	...	...
3178	80	108	3.7	1.2	Yellow	64.8	4.7	92.7	16.9	...
3179	100	112	3.7	1.2	Yellow	61.2	15.8	74.2	13.8	1802
3180	150	117	3.7	1.2	Yellow	53.5	43.0	19.5	7.8	1721

in the storage tank from room temperature to the maximum temperature of 150°C. As temperature approached the maximum it was found necessary to use gas relief from the top of the storage tank. The cold liquor charged, 600 lb. of liquor per charge occupying 75% of the tank volume, was usually in the neighborhood of 5.0% to 6.0% total SO_2, 1.0% combined SO_2 (as indicated by TAPPI Standard T 604 m-45 and by the Palmrose method). Tank pressure rose rapidly as temperature increased. During the heating cycle, relief was controlled to keep maximum total pressure at 150 p.s.i.g.

A calibrated measuring tank, equipped with a level gage, connected to the hot-liquor tank was used for charging measured quantities of cooking liquor into any of the six digesters through flexible stainless steel hose. Suitable valving permitted filling of the measuring tank from the hot-liquor tank, closing all interconnections between tanks except in a pressure equalizing line at the top, then forcing a measured quantity of liquor from the measuring tank into the digester.

The wood used in all cooks was northern spruce obtained from central Maine. Since the logs had partially dried out during shipment, they were water-soaked for three days before chipping. Two types of chips were used in the experiments—the usual mill-size chip used in commercial operations and shredded chips—the mill-size chips were split along the grain into splinters as long in the grain direction as the original chip but whose cross-sections were such that the splinters would pass endwise through a 3-mesh screen but be retained on a 10-mesh screen. Details of chipping, screening, and shredding have been previously described (*3*). All chips were air-dried to prevent deterioration during storage.

For each cook, a weighed sample of airdry chips (1000 g. of O.D. wood) was submerged in water for 6.0 hr., drained and reweighed. From these data the moisture content of the chips, as charged, was evaluated; usually 55 to 65% moisture. The chip sample was charged to a hot digester and a measured quantity of preheated liquor (7 liters at room temperature) was charged to the digester. Total charging time for both chips and liquor was 2.0 min. or less. As soon as the digester was completely charged pressure was relieved through the top valve, usually to a pressure in the range of 105 to 110 p.s.i.g. Rotation of the digesters at 3 r.p.m. was then started. Two minutes before the

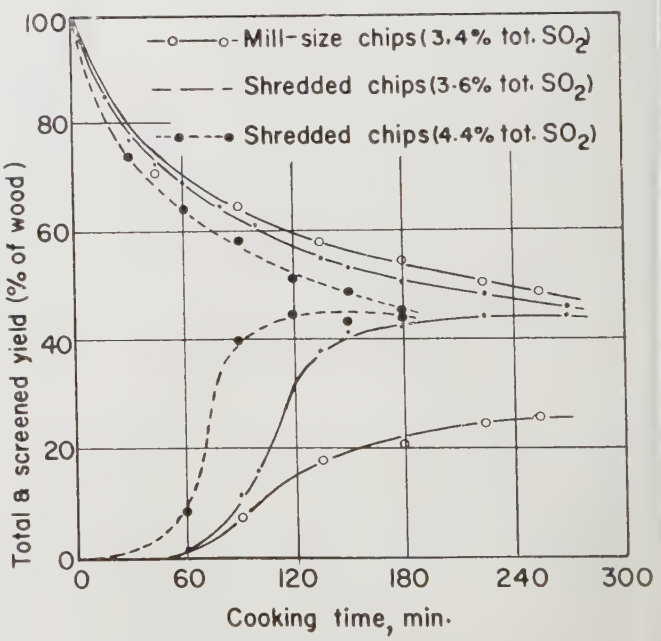


Fig. 1. Constant-temperature cooking curves

7.0 Lb. of acid bisulfite liquor (NH_3 base) per lb. wood; cooking temperature, 148°C.

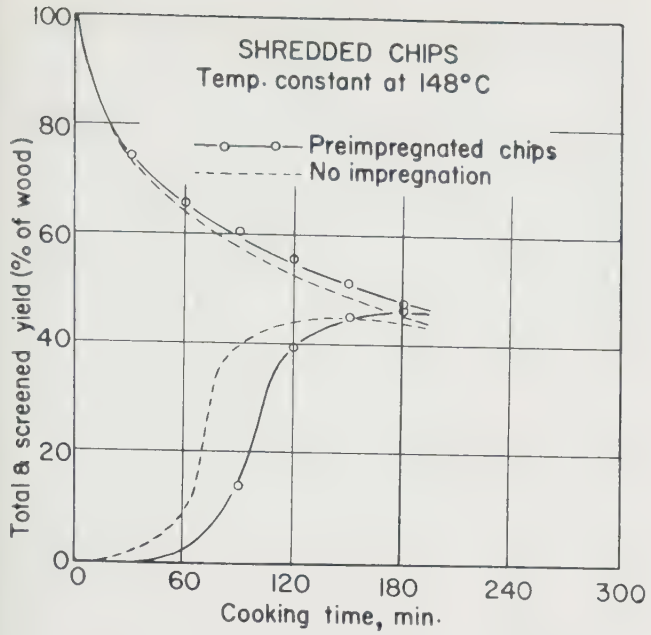


Fig. 2. Effect of pre-impregnation on pulping rate

Impregnating liquor, acid bisulfite, 6.1% total SO_2; cooking liquor, acid bisulfite, 4.1% total SO_2.

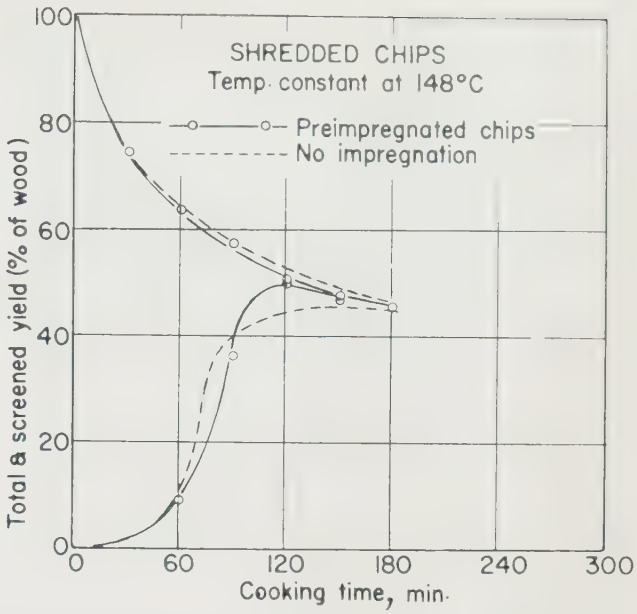


Figure 3. Effect of pre-impregnation on pulping rate

Impregnating liquor, bisulfite, 2.3% total SO_2; cooking liquor, acid bisulfite, 4.5% total SO_2.

end of the cook rotation was stopped, the bottom blow valve was connected to the cyclone blow pit and the top valve was connected to the hot water wash tank. The digester was blown and two charges of hot water were charged to the digester and blown to the blow pit.

In some cases, chips were pre-impregnated with liquor before pulping. Mill-size chips were pre-impregnated with cooking liquor of the same strength, in both total and combined sulfur dioxide, as the liquor pumped to the hot-liquor tank. In the case of shredded chips, two types of impregnating liquor were used: one type was identical to the original cooking liquor, whereas the second type contained only NH_4HSO_3 with no excess H_2SO_3.

Two different procedures for impregnation were employed. When cooking liquor was the impregnant, airdry chips were charged into a closed vessel at room temperature and a vacuum was applied at the top of the vessel; a pressure of 5.0 mm. Hg abs. was held for 30 min. At the end of this period, a connecting valve to a carboy of cooking liquor was opened and liquor flowed into the bottom of the vessel until the chips were covered with liquor. Chips remained in contact with the liquor for 30 min. before they were removed from the vessel. A few of the pre-impregnated chips were cut open after the impregnation procedure and inspected for penetration. Penetration appeared to be complete for the shredded chips, but some of the larger chips indicated that liquor had not reached the centers of the chips. This method of impregnation follows the procedure described by Jayme and Lochmuller-Kerler (*4*). By this procedure, 1.7 to 2.2 lb. liquor per pound dry chips was absorbed.

In the case of impregnating shredded chips with NH_4HSO_3 solutions, the chips were submerged in the liquor, boiled for 10 min., then cooled to 60°C. while still submerged (*3*). The liquor pickup by this procedure amounted to 2.0 lb. liquor per pound dry chips.

The pre-impregnated chips were cooked in exactly the same manner as were the chips in which water was the only impregnant. The same quantity of hot cooking liquor, corresponding to 7 liters at room temperature, was used.

In addition to the six cooks carried out for each set of conditions, one digester was charged with liquor alone. The pressure in this digester was measured immediately after charging, no relief being used. The liquor was held in the digester for 3 hr., at which point a sample was removed through a condenser and analyzed for total and free sulfur dioxide. The remainder of the charge was then blown to the sewer. This liquor analysis was used to estimate liquor concentration at the start of each cook in a manner which will be described later. No analyses were attempted on the waste liquors from the actual cooks. Samples of these liquors were examined visually for color and turbidity.

All pulps were thoroughly washed and screened; yield values, both total and screened, were determined. Screened pulps were analyzed for lignin content. The D.P. of the cellulose in most of the screened pulps was also determined. Pentosan content of the pulps was not evaluated. Procedures and methods of analysis used have been described in a previous publication (*3*).

The cooking data are reported in Table I. The cooking curves, total and screened yield vs. cooking time, for those cooks without pre-impregnation of liquor are shown in Fig. 1, while similar curves using pre-impregnation for shredded chips are shown in Figs. 2 and 3.

DISCUSSION

Analysis of the Cooking Data

Figure 1 and Table I show that mill-size chips cannot be cooked successfully at constant, elevated temperatures. The screened-yield curve becomes almost parallel to the horizontal axis at a value of 27.4%. The fact that screened yield remains almost constant while total yield is decreasing indicates that cellulose is being dissolved as rapidly as the uncooked wood

(at or near the centers of the chips) is being delignified into individual fibers.

This very low screened yield for mill-size chips can be explained, in part, by the elapsed time required to reach the maximum screened yield. The 4.5 hr. at 148°C. provided sufficient time for the autoxidation–reduction reactions to convert appreciable quantities of sulfur dixoide to sulfur trioxide and elemental sulfur, borne out by the color of the waste cooking liquor and the D.P. of the cellulose in the screened pulp. The data indicate that at about 180 min. sufficient H_2SO_4 had been produced to overcome the mild buffering action of the combined chemical, NH_4HSO_3, and to create sufficiently high acidity to condense the remaining lignin and attack the cellulose. The series of cooks numbered 3199 through 3204 (an attempt at exact duplications of series 3193 through 3198) showed a slightly prolonged buffering action, probably caused by the slightly higher initial value of combined chemical.

The cooking data and the curves in Fig. 1 show that the shredded chips, on the other hand, can be cooked successfully at constant, elevated temperatures. The reason for this is obvious. The shredded chips present considerably more surface than the mill-size chips for the delignification reaction and the distance which the reaction must traverse to delignify the center of the chips is quite short, within the range of 0.03 to 0.13 in. This change in the physical dimensions of the chips permitted the attainment of approximately maximum screened yield in 3.5 hr. or less.

The cooking series numbered 3175 through 3180, 3181 through 3186, and 3205 through 3210 were attempts at exact duplication of conditions, including an initial liquor concentration averaging 3.6% total SO_2 and 1.2% combined. Another series, numbered 3223 through 3228, used a liquor of somewhat higher initial concentration, 4.4% total SO_2. It can be seen that this increase in concentration accelerated the delignification, permitting the attainment of maximum screened yield in 2 hr.

Although the data show that shredded chips can be pulped at constant temperature, neither screened yield nor quality of pulp, as measured by D.P. is as high as can be produced by batch methods, where screened yields of 50.0% and a D.P. of 1800 to 2000 are possible. In order to attain a yield and quality in constant temperature pulping which is comparable to the results from batch operations, either initial liquor concentration or temperature, or both, must be increased so that maximum screened yield can be attained in 60 to 90 min.

At this point it should be explained why initial concentrations of total sulfur dixoide were limited to values under 5.0%. This was caused primarily by the working pressure limitations of the hot liquor storage tank and of the digesters. These units were designed for 200 p.s.i.g. operating pressure. In view of the high pressures developed by the hot liquor, gas relief was used on the liquor tank to limit maximum pressure to 155 p.s.i. as temperature rose to 150°C. This relief entailed considerable loss in free sulfur dioxide, even though the strength of the raw liquor was as high as 6.0% total SO_2. In addition, vaporization occurred in both the liquor tank and in the digesters during filling. The liquor tank was only three-fourths full when charged, and the digester volume was not filled with liquor at the start of the cook. (The digesters had a capacity of 14 liters; the liquor charged was 7 liters at room temperature or 7.8 liters at 148°C.) Finally, an unknown amount of sulfur dioxide was converted to sulfur trioxide and sulfur by the autoxidation–reduction reaction, both in the hot liquor storage tank and in the digester during the cook. An indirect calculation, which will be explained later in the discussion, was used to arrive at the values of initial liquor concentration in Table I.

The effects of pre-impregnation on the rate of pulping during constant-temperature operations can be discussed only qualitatively because of the very limited data available at this time. The data show, for both mill-size and shredded chips, that no increase in delignification was brought about by the pre-impregnation of liquor into the fibers during the first 90 min. of cooking. This is quite surprising in view of the old accepted theory of batch pulping which states that liquor must completely penetrate the chips before temperatures sufficiently high for delignification are reached. The theory implies that, once the liquor has entered all the fiber lumens and temperature is sufficiently high,the lignin surrounding all the fibers will react with the liquor diffusing through the porous cell walls. In addition, the liquor is actually in contact with lignin at the bordered pits. If such a mechanism were actually true, prepenetration of the liquor into the chips before the cook starts should result in a greatly accelerated lignin removal in the early stages of a constant-temperature cook. The data indicate that no such early acceleration of lignin removal occurred.

Where the acceleration in delignification and consequent increase in screened yield actually occurred was in the cooking interval after 90 min. of constant-temperature pulping had already taken place. This would indicate that the prepenetration liquor supplied an increased quantity of liquor (amounting to almost 30% of the separately charged liquor) which tended to sustain the concentration of HSO_3^- ions and of the buffering bisulfite, NH_4HSO_3. The sustained concentration of HSO_3^- ions permitted a somewhat higher sulfonation rate during the interval 90 to 180 min. of cooking time, and the increased bisulfite tended to suppress acidity for a somewhat longer period than when no pre-impregnation was used. These conclusions are supported by a comparison of screened yield, D.P. and waste liquor color for the pre-impregnated cooks and those without impregnation listed in Table I.

The data indicate that increased concentrations of cooking chemicals and increased temperature might shorten cooking time to a practical range and increase screened yield cellulose quality to values equal or superior to those realized in present batch methods. The combination of increased concentration and temperature, along with pre-impregnation of bisulfite liquor, may be found to be the best practice. The need for greatly expanded research in this field appears obvious.

These increases in temperature and concentration involve several undesirable complications in addition to the desirable effects of increased reaction rates. Such factors as increases in operating pressure, corro-

sion rate, acidity, and sulfur dioxide loss through autoxidation–reduction will be taken up later in the discussion.

The Mechanism of the Pulping Reactions

It is undoubtedly true that the pulping variables in high speed, continuous pulping will have a more degrading effect on cellulose than the corresponding values of the variables in the much slower, batch cook. Therefore, it becomes necessary to know just how the reacting chemicals come in contact with the lignin and the cellulose and whether any steps can be taken to promote the reaction with lignin and to suppress cellulose reaction.

As has been stated earlier, it has long been assumed that sufficient time must be provided for complete penetration of the cooking liquor into all the hollow lumens of the cellulose fibers in the chips before the temperature can be elevated to such a point that delignification takes place. In conventional batch pulping, temperature schedules are so arranged that this early penetration undoubtedly occurs. For the first 2 to 3 hr. of the cook the temperature of the liquor and the chips submerged in the liquor is held at about 105°C. This provides sufficient time for air to be expelled from the chips, for liquor to flow into the spaces made available by the escaping air or gas and to mix with the moisture in the chips. It is assumed, under these circumstances, that as the temperature of the system increases delignification takes place more or less uniformly throughout the chips.

A simple consideration of the facts will show that only a small percentage of the cooking liquor necessary for complete pulping is forced into the chips, even with 100% penetration. Common practice dictates that a total of at least 5.0 lb. of liquor be used per pound of O.D. wood charged. Let it be assumed that the fresh chips contain only 35% moisture, a value considerably lower than for freshly cut chips. This amounts to 0.54 lb. water per pound of O.D. wood. It is known that wood chips, when completely saturated with water, will contain about 2.0 lb. of water per pound of O.D. wood. Therefore, the amount of cooking liquor inside the chips, available through penetration for the delignification, is only 2 − 0.54, or 1.46 lb. per lb. of O.D. wood. This amounts to 29% of the liquor considered necessary for complete pulping. Therefore, since most of the active chemical is in the liquor outside the chips it would seem logical to assume that most of the delignification starts at the surface and proceeds toward the chip centers.

This assumption is confirmed by the results of this investigation and the results of earlier research (*5*) involving the batch pulping of both shredded and mill-size chips, in which 30 min., 6.0-hr. and 9.0-hr. periods were allowed for the digester to reach the maximum temperature. In these experiments, as in the present research, the chips were pre-impregnated with water so that there was practically no volume in these chips available for the penetration of the liquor.

In these batch-pulping experiments, the use of 6.0 and 9.0 hr. to maximum temperature resulted in cooks which were just as rapid and which were at least as high in quality and screened yield as in standard mill procedures in which penetration actually occurred. In all cases, the shredded chips pulped more rapidly and to considerably higher screened yields than did the mill-size chips. At 30 min. to maximum temperature shredded chips cooked to high yield and quality in a total time of 2.5 hr., while the larger chips could not be cooked successfully under these drastic conditions. It is, therefore, apparent that penetration early in the cook is not necessary and that the surface exposed per unit weight of wood and the distance from the surface to the center of the chip have a definite influence on the rate of pulping and quality of product.

The experimental evidence suggests that the mechanism by which delignification takes place might be identical to the moving reaction interface proposed for kraft pulping (*6*). This theory states that the delignification reaction starts at the interface between liquor and chip. As partial delignification of the outer fibers occurs, channels around these fibers are formed, permitting an inward diffusion of liquor to the completely lignified fibers farther toward the chip center, thus setting up a new interface between liquor and completely unreacted wood. This moving reaction interface leaves behind it a reaction zone, bounded on the outside by the original chip surface and on the inside by the interface itself.

There is a lignin gradient across this reaction zone. At the interface the lignin content of the fibers is that of the original wood. At the chip surface the lignin content of the fibers will be at some value between zero and the original lignin content of the wood, dependent on time, concentration, and temperature of the reaction.

There is also a liquor concentration gradient across the reaction zone. At the outside of the chip the concentration is that of the main body of the liquor. At the reaction interface it is at a much lower value, depending on the rate of diffusion and on how much delignification is occurring across the zone.

As the reaction interface moves toward the chip center, there will be some definite lignin content of the fibers near the surface at which the forces accompanying the digester blow will be greater than the bond between these fibers and the main body of the chip. It is at this point that screened pulp first appears in the blown cook. Past experience has shown that this critical lignin content at which fibers first break away from the chip is in the range of 16 to 20%. Of course, when the chip remains in the digester for increased periods of time the lignin content of the screened pulp will be an average between the lignin content of the fibers at the chip surface, and this 16 to 20% value for those fibers farther inside the reaction zone where they can just break away from the chip.

This change in lignin content of the fibers from the surface of the chip to the center causes corresponding changes in the degree of degradation of the cellulose. The cellulose fibers at or near the surface of the chip lose part or all of their protective sheath of lignin rather early in the cook, while fibers farther inside the reaction zone are completely covered. Consequently, the outer fibers, being in complete contact with the liquor, are degraded rapidly and may actually dissolve as their chain length becomes sufficiently short. This accounts for the constancy of or even decrease in screened yield late in the cook even though uncooked wood at the chip center is still being converted into new pulp fibers.

These considerations show why it is impossible to produce completely uniform pulps from wood chips. In every suspension of pulp fibers, some fibers will contain more lignin than others and the chain length of the cellulose will vary directly with the lignin content of the fibers. Differences in overall quality between two pulps of the same average lignin content and D.P. will be dependent on the maximum variations from the mean values of lignin and D.P.

This proposed explanation of the mechanism of pulping accounts for the decrease in cooking time and the increase in screened yield and D.P. when shredded chips are used instead of mill size chips. The distance from the surface to the chip centers is so much shorter that the reaction reaches the center of the chip faster and degradation of the outer fibers is less. The smaller in cross-sections these shredded chips can be made without excessive mechanical damage to the fibers, the more efficient will be the pulping operation.

Arguments other than those just mentioned can be used in support of this moving interface of reaction. The lignin content of a screened pulp and the changes in this lignin content with increases in screened yield support the theory. Table I shows that lignin content of the pulp varied inversely with the percentage of screened pulp produced. Very early in the cook, when only surface fibers are broken away from the chips to form screened yield, the screened yield is very low—1.2% to about 7.4% of the total woody residue—and the lignin content is high: 16 to 21.5%. As screened yield becomes greater, the fibers that were first released become lower in lignin and, even though the newly released fibers are high in lignin, the overall average lignin content of the fiber mixture becomes lower. It is interesting to note that even in the pre-impregnated cooks the fibers that are first released are high in lignin, indicating that the chemical inside the fiber lumens is not attacking the lignin in the middle lamella surrounding the fiber. Apparently the cell wall offers too much resistance to diffusion of either the fresh chemicals or to the more viscous reaction products.

Another argument in favor of the moving interface of reaction lies in the appearance of the screenings, or uncooked chip centers, when the digester charge is blown. The screenings, as the cook progresses, remain relatively long in the grain direction but become considerably shorter in the cross-grain direction. This could not be true if the chemicals were attacking the lignin by diffusion from the fiber lumens, through the cell wall to the lignin surface surrounding the fibers. It is a proved fact that diffusion of liquids into chips occurs above one hundred times as fast in the grain direction as in the cross-grain direction. If the old penetration theory were correct, the screenings would become increasingly short in the grain directions, not in the cross-grain directions, since fresh liquor could diffuse relatively rapidly into the ends of the chip to replenish consumed chemicals and the reaction products could diffuse outward.

The author has cut cross-sections through the centers of these uncooked screenings on numerous occasions in kraft, neutral sulfite and acid bisulfite pulping. On every occasion, until screenings cross-sections become quite small, completely unmodified wood can be seen at the centers. Outside this untouched wood is a band of discolored, softened wood, while at the surface of the screening there is a fuzzy layer of soft, fibrous material which can be easily pulled away from the main body. In acid bisulfite pulping, this outer coat is particularly striking because it is almost white, while the harder layer just inside this band is brown and the untouched center remains the natural color of the wood. Photographs have been taken of these chip cross-sections and these differences in structure appear quite clearly.

This concept of the mechanism dictates that everything possible should be done to decrease the distance which the reaction must travel from the surface to the center of the chip and to increase the speed with which the reaction interface moves toward the center. The decrease in path must be obtained, primarily, through reduction in cross-section across the grain. Decreases in chip length involve the cutting of increased quantities of fibers, causing a mechanical degradation of the fibers.

The speed of reaction is governed by the chemical driving forces, liquor concentration and temperature. Increases in these two variables will definitely increase the speed of the delignification reaction. However, they must be used with care as they will also accelerate the rate at which the chemicals degrade the cellulose. Also, the rate of autoxidation–reduction of sulfur dioxide will increase with increasing temperature and will, if unchecked, increase acidity to the point where extremely rapid degradation occurs. Therefore, extensive research must be undertaken to evaluate the effects of these two variables.

One other independent variable may be changed with relative safety chemically; that is the weight ratio of cooking liquor to wood. At high ratios, somewhat lower initial concentrations may be used and the average concentration over the entire cook may be maintained at a higher level than when low ratios are used. However, the digester system must be so designed that the increased quantities of liquor can be recirculated within the system itself rather than discharged with the pulp so that the liquor recovery system will not be overloaded.

The Effects of Autoxidation–Reduction of Sulfur Dioxide

The active pulping chemicals in the acid bisulfite liquor are H_2SO_3 and NH_4HSO_3. The concentration of the free acid in the solution is controlled by the vapor pressure of the sulfur dixoide in the gas phase, by the dissociation constant of the weak acid and by the common ion effect of the NH_4HSO_3 as follows:

$$SO_2 + H_2O = H_2SO_3 = H^+ + HSO_3^- \qquad (1)$$

Since the system contains a large excess of SO_2, practically all the NH_3 should be in the liquid phase, exerting neligible vapor pressure, as follows:

$$NH_4HSO_3 = NH_4^+ + HSO_3^- \qquad (2)$$

The H_2SO_3 is only slightly ionized, whereas ionization is almost complete for the NH_4HSO_3.

Several possible mechanisms have been proposed for the sulfonation of lignin, one proposed by Hägglund (7), is:

$$R-OH + HSO_3H \rightarrow R-SO_3H + H_2O \qquad (3)$$

The lignin sulfonates first formed are insoluble in the cooking acid but, as acid hydrolysis takes place, the lignin molecules are broken down into molecules of lower molecular weight, the sulfonates of which are soluble. These soluble lignin sulfonates are highly ionized and tend to increase the acidity of the system, driving the equilibrium of equation (1) to the left. The presence of NH_4HSO_3, however, provides a buffering action which will counteract the increased acidity of the lignin sulfonates.

The autoxidation–reduction of sulfur dioxide as explained by Marusawa (*1*), can be expressed as follows:

$$3H_2SO_3 \rightarrow 2H_2SO_4 + S + H_2O \qquad (4)$$

The sulfuric acid will ionize almost completely as:

$$H_2SO_4 = H^+ + HSO_4^- \qquad (5)$$

This autoxidation–reduction, if it occurs at an appreciable rate, can have a serious effect on the pulping reaction. Working in conjunction with the highly ionized lignin sulfonates it can overcome the buffering action of the NH_4HSO_3 and increase the acidity of the cooking liquor sufficiently to condense the lignin molecules to an insoluble or "burned" condition, and to degrade the cellulose.

This autoxidation–reduction reaction has never created too serious a problem in conventional batch pulping. With the very long temperature-rise schedules employed, a very high proportion of the total reaction occurs before maximum temperature is reached. For example, if 6 hr. are used to reach a maximum temperature of 142°C., about 60% of the pulping reaction has been completed by the time maximum temperature is reached. If 9 hr. are allowed to attain a maximum temperature of 135°C., almost 80% of the total reaction occurs during the temperature-rise period. The time at maximum temperature, under such circumstances, does not exceed 3 to 4 hr. At these reduced temperatures equation (4) does not exercise a controlling effect on the overall pulping reactions.

In constant-temperature pulping, however, this autoxidation–reduction of sulfur dioxide can have a decided effect on the pulping operation. There is a tendency to use increasingly high temperature in order to decrease cooking time. These higher temperatures accelerate the rate of reaction of equation (4), as well as the delignification reaction. Therefore, the kinetics of the oxidation–reduction reaction, as well as the usual pulping reactions, must be evaluated under actual operating conditions.

TAPPI Standard for T 604 m-45 analysis of sulfite liquors, or the alternate Palmrose method, may be used to study the rate of conversion of sulfur dioxide to sulfur trioxide and sulfur. Let it be assumed that cooking liquor of known concentration is to be injected into a digester at high temperature, and sampled periodically for conversion of sulfur dioxide to sulfur trioxide and sulfur. The TAPPI Standard method of titration is to be used. In analyzing the original lignin, the iodine titration oxidizes all SO_3^{2-} ions to SO_4^{2-} and gives a true measure of total sulfur dioxide in solution. The sodium hydroxide titration converts all free sulfurous acid and all bisulfite to normal sulfites. If it is considered that 32 g. of SO_2 is equivalent to 40 g. of NaOH, as is done in both the TAPPI and the Palmrose methods, the sodium hydroxide titration measures all of the sulfur dioxide which is present in the original liquor as H_2SO_3 and half of the sulfur dioxide which is present as NH_4HSO_3. If the sulfur dioxide calculated from the sodium hydroxide titration (designated as free SO_2 in the sulfite industry) is subtracted from the total sulfur dioxide as calculated from the iodine titration, a measure of half of the sulfur dioxide present as NH_4HSO_3 results. This is called combined sulfur dioxide by the sulfite industry.

If, after a definite time at elevated temperature, this same liquor is sampled and analyzed by the TAPPI method, the iodine titration will measure that quantity of sulfur dioxide which has not been converted to sulfur trioxide and sulfur. The sodium hydroxide titration will measure all the sulfur dioxide present as H_2SO_3, half the sulfur dioxide present as NH_4HSO_3 and all sulfur trioxide present as H_2SO_4. The TAPPI method, however, converts the equivalents of NaOH to SO_2, reporting the SO_3 as SO_2. Subtraction of this calculated sulfur dioxide obtained as a result of the sodium hydroxide titration from the sulfur dioxide calculated from the iodine titration will measure half the sulfur dioxide present as NH_4HSO_3 less the amount of sulfur dioxide converted to sulfur trioxide. Subtraction of this new value of combined sulfur dioxide from the combined sulfur dioxide in the original liquor gives the quantity of sulfur dioxide which has been converted to sulfur trioxide. This figure multiplied by 1.5 gives the total sulfur dioxide which was lost by autoxidation–reduction [equation (4)].

An illustration will show how this method can be used to follow the conversion of sulfur dioxide to sulfur trioxide and how it was actually used to calculate the initial concentration of cooking liquor in Table I. In the series of cooks numbered 3229 through 3234, one digester was charged. Its pressure, without relief, was 137 p.s.i.g. At the end of 3 hr. a sample of the liquor was withdrawn from the digester, cooled and analyzed by the TAPPI method. Analyses of this liquor and of the original liquor, before heating, were as shown in Table II.

Table II

	Original liquor % of solution	*Final liquor % of solution*
Total SO_2	6.58	4.09
Free SO_2	5.40	3.44
Combined SO_2	1.18	0.65

The difference in the analyses of the original and final liquors represent not only the loss by oxidation–reduction but also those losses in sulfur dioxide incurred by relieving the liquor tank and by injecting 7.8 liters of hot liquor into a volume of 14 liters. However, the original analysis of the liquor at the time the cook started can be calculated if it is assumed that the oxidation–reduction occurred equally in the digester and in the hot-liquor tank. This is approximately true, since retention time at maximum temperature was about the same in both vessels. The following calculation shows the conversion of the final liquor analysis to that at the start of the cook:

Total SO_2 converted to SO_3 = 1.18 − 0.65 = 0.53 g./100 g. solution
SO_2 converted in digester = 0.53/2 = 0.265 g.
SO_2 converted to S in digester = 0.265/2 = 0.132 g.

Total SO_2 at start of cook = 4.09 + 0.265 + 0.132 = 4.487%
Free SO_2 at start of cook = 3.44 − 0.265 + 0.132 = 3.308%
Combined SO_2 (by difference) = 1.179%

The true analysis of the final liquor for SO_2 would be:

Total SO_2 = 4.09%
Free SO_2 = 3.44 − 0.53 = 2.91%
Combined SO_2 (by difference) = 1.18%

New experimental digesters, fabricated from Nionel, are now being constructed to study this autoxidation–reduction reaction, as well as to continue the explorations of the other pulping variables. The equipment is designed for operating pressures as high as 300 p.s.i.g., eliminating the need for digester relief at moderately high pulping temperatures. It is hoped that empirical kinetic equations can be developed for the velocity of this oxidation–reduction reaction, as well as for the pulping reaction itself. Such information would be invaluable in estimating the possibilities of high speed, continuous pulping.

Even if the rate of oxidation–reduction of sulfur dioxide increases more rapidly with temperature than the pulping rate, continuous pulping need not be considered impractical. Proper design of a continuous digester system, in which a relatively large fraction of digester liquor is recirculated at maximum cooking temperature, would permit continuous injections of base to the recirculation liquor, forming an inert bisulfate which would not interfere with the cook. This sulfate would be reduced in the recovery system to active pulping chemicals. Whether or not such a procedure would be economically sound cannot be predicted at this time.

Operating Pressures Involved in Continuous Pulping

The temperatures involved in high speed operations will entail much higher operating pressures than are now used in batch pulping. Also, it would be impractical in continuous pulping to resort to continuous relief of sulfur dioxide to reduce these pressures. Therefore, it becomes necessary to estimate the range of pressures that can be expected under such conditions.

Practically all of the available data on vapor pressures of acid bisulfite liquors are confined to low temperatures and to pressures below 1.0 atm. The data of Marriner and Whitney (*8*) present vapor pressure data for various combinations of total and combined sulfur dioxide at temperatures of 4.5, 10.0, 18.0, and 25.0°C. With no experimental data on vapor pressures in the range of 140 to 160°C. available, extrapolation of the low temperature data involves a high degree of uncertainty. However, as was mentioned earlier, one digester was charged with liquor alone at 148°C. and pressure was not relieved throughout the 3 hr. retention time. From this run, the vapor pressure of sulfur dioxide at the liquor concentration and temperature can be computed.

The vapor pressure of sulfur dioxide for a cooking liquor containing 4.5% total SO_2 and 1.2% combined SO_2 at a temperature of 148°C. is calculated as follows:

Total pressure (measured) = 137 + 14.7 = 151.7 p.s.i. abs.
Vapor pressure of water at 148°C. = 65.5 p.s.i. abs.

Calculation of mole fraction of water in the cooking liquor:

Basis: 100 lb. solution.
Weight of NH_4HSO_3 = 1.2 × 2.0 × 99/64 = 3.71 lb.
Weight of H_2SO_3 = (4.5 − 1.2 × 2.0) × 82/64 = 2.66 lb.
6.37 lb.

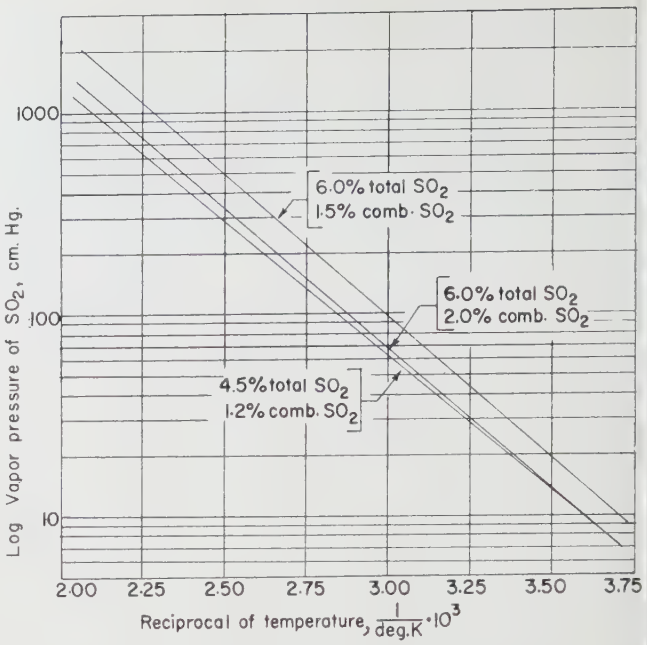


Fig. 4. Vapor pressure of acid bisulfite liquors

Ammonia base

Weight of water = 100 − 6.37 = 93.63 lb.
Moles water = 93.63/18 = 5.200
Moles NH_4HSO_3 = 3.71/99 = 0.037
Moles H_2SO_3 = 2.66/82 = 0.033
5.270

Mole fraction of water = 5.20/5.27 = 0.988
Partial pressure of water vapor over the solutions = 0.988 × 65.5 = 64.7 p.s.i. abs.
Pressure of SO_2 in vapor = 151.7 − 64.7 = 87.0 p.s.i. abs. = 5.92 atm.

Once this vapor pressure of sulfur dioxide is known it is possible to calculate the amount of sulfur dioxide which was lost from the entering solution to the vapor space. The following data are known:

Volume of liquid = 7.8 liters
Volume of vapor = 14.0 − 7.8 = 6.2 liters
Temperature = 148°C. = 421°K.
Pressure of SO_2 = 5.92 atm.
Critical pressure, SO_2 = 77.7 atm.
Critical temperature, SO_2 = 430°K.

In the equation,

$$PV = CnRT$$

C is the compressibility constant, a function of reduced pressure, P/R, and reduced temperature, T/R,

$$P/R = \frac{5.92}{77.2} = 0.0768$$

$$T/R = \frac{421}{430} = 0.978$$

Smith (*9*) gives a value of $C = 0.98$ for these values of P/R and T/R. Therefore, the number of moles of SO_2 vapor, n, can be computed from:

$$n = \frac{PV}{CRT} = \frac{5.92 \times 6.2}{0.98 \times 0.082 \times 421} = 1.805 \text{ g. mole} = \frac{1.085 \times 64}{453} = 0.153 \text{ lb}$$

Weight of free SO_2 present in liquor after flashing (assuming sp. gr. = 1.00)

$$= \frac{7.8 \times 1000\,(0.045 - 0.012 \times 2)}{453} = 0.362 \text{ lb.}$$

Table III. Vapor Pressures of SO_2 in Cooking Liquors[a]

Liquor analysis, % SO_2 Total	Combined	Temperature of liquor, °C.	Vapor Pressure of SO_2 cm. Hg	atm.
4.5	1.2	4.5	8.9	
		10.0	11.2	
		18.0	16.2	
		25.0	20.4	
		148.0	435	5.73
		160.0	530.0	6.98
		170.0	610.0	8.03
6.0	2.0	4.5	9.0	
		10.0	11.5	
		18.0	16.7	
		25.0	20.8	
		148.0	505.0	6.65
		160.0	630.0	8.30
		170.0	735.0	9.68
6.0	1.5	4.5	13.1	
		10.0	16.7	
		18.0	24.0	
		25.0	30.0	
		148.0	750.0	9.87
		160.0	935.0	12.30
		170.0	1100.0	14.47

[a] Vapor pressures at 4.5, 10.0, 18.0, and 25.0°C. interpolated from data of Marriner and Whitney (*8*). All other vapor pressures read from Fig. 4.

Percentage of entering free SO_2 vaporized = $(0.153 \times 100)/(0.362 + 0.153) = 29.7\%$.

The data of Marriner and Whitney (*8*) were interpolated to give the vapor pressures of sulfur dioxide for the solution containing 4.5% total SO_2 and 1.2% combined SO_2 at the temperatures of 4.5, 10.0, 18.0, and 25°C. These data are listed in Table III. The logarithm of vapor pressure was then plotted against the reciprocal of the absolute temperature. A straight line was drawn through these points and extended to cover the range of 140 to 170°C., as shown in Fig. 4.

The extrapolated value for vapor pressure of this solution at 148°C. was found to be 435 cm. Hg, or 5.73 atm. This is in very good agreement with the experimental value of 5.92 atm. when one considers the degree of extrapolation and the fact that the critical temperature for sulfur dioxide is 158°C., very close to the operating temperature of 148°C.

In view of this apparently accurate method of extrapolation it was decided to use this relationship to predict pressures which might be expected at increased concentrations of cooking liquor and somewhat higher temperatures. Additional interpolated values of vapor pressure from the low temperature data of Marriner and Whitney (*8*) are listed in Table II and the straight line, semilogarithmic plots of these data are shown in Fig. 4. Extrapolated vapor pressures for these elevated temperatures, read from Fig. 4, are listed in Table II.

If further research indicates that temperatures of about 160°C. and liquor concentrations of about 6.0% total SO_2 and 2.0% combined SO_2 might be required, it can be expected that the digester will have to withstand about $8.30 \times 14.7 + 89.7$ or 212 p.s.i. abs. At 170°C. with the same cooking liquor, total initial pressure will be about 258 p.s.i. abs.

For a cooking liquor with an initial concentration of 6.0% total SO_2 and 1.5% combined SO_2, the operating pressure at 160°C. will be about p.s.i. abs., whereas at 170°C. the operating pressure will be 328 p.s.i. abs. It is, therefore, apparent that the digester should be designed for about 350 p.s.i. working pressure, if temperatures of about 160°C. and cooking liquor concentration in the range of 6.0% total SO_2 are to be used.

Corrosion Problems in Continuous Pulping

The corrosive conditions encountered in a continuous digester will be very severe and, at this point in the development, it is difficult to specify the alloys that can be used successfully. The liquors will be much more corrosive than in conventional batch pulping where maximum temperatures are 145°C. or less and where H_2SO_3 concentrations have been reduced by continuous relief as the temperature rises. In the newer batch digester it has been found necessary to resort to the use of stainless steel of type 316L. In one case at least, digesters fabricated from this corrosion-resistant alloy have developed severe pitting, particularly in the upper sections where surfaces are in contact alternately with the liquid and vapor phases.

The experience of the sulfite industry in digester corrosion is of comparatively recent origin because of the practice of using acid brick lining in mild steel, riveted vessels. The few unlined digester installations have not yet accumulated sufficient corrosion information to indicate which alloys are best suited for even the milder batch conditions. Therefore it becomes necessary to begin corrosion studies on an experimental scale while the operating conditions for continuous pulping are being worked out.

The system does not lend itself to the usual techniques for accelerated corrosion testing. As temperature is increased to accelerate corrosion rate, the corroding chemicals themselves change. The H_2SO_3 is converted to H_2SO_4 and the corrosion characteristics of the solution change. Since there are no commercial digesters in operation under the conditions being discussed, only two avenues of approach appear available.

The first and easier approach uses the experimental digesters as the corrosion testing equipment. As mentioned earlier, the digesters now being built at the laboratory are fabricated from Nionel. Small strips of various alloys will be hung in one of the digesters and examined periodically for changes in surface and in weight. The rotation of the digesters will insure that the samples will be alternately in the liquid and vapor phases, simulating the worst conditions in the digester, at the dome. This method has the disadvantage of being slow in that the only time available for testing will be those few hours in the day when the digesters are in operation.

Another, more complicated procedure is available in which the corrosion test could be carried out continuously. A large supply of liquor could be forced by air pressure at a slow rate through a heat exchanger into the bottom of a steam-jacketed pressure vessel. A valve at the top of the vessel could be cracked sufficiently to allow the slow flow of liquor while maintaining pressure in the vessel. The exit liquor could be cooled and re-used after adjustment of concentration or it could be sewered. Test samples could be hung in the pressure vessel and examined periodically. This system would have the advantage that higher accelerating temperatures could be used, since retention time in the vessel would be small. However, one major disadvantage lies in the fact that the organic acids formed in the cook, which may influence corrosion to a high degree, would not be present.

In any event, some method must be devised to evaluate the corrosion characteristics of this modified

acid bisulfite process so that appropriate materials of construction can be specified. If these materials of construction make the equipment cost prohibitive, the process becomes impractical, regardless of what advantages may accrue in the way of increased yield and quality of pulp or improved steam economy.

LITERATURE CITED

1. Marusawa, R., *Eng. Chem. J. (Japan)* 1, 194–206 (1921).
2. Harvin, R. L., Hills, G. B., Jr., Rothrock, C. W., Jr., and Nolan, W. J., *Tappi* 33, No. 7, 338–343 (July, 1950).
3. Nolan, W. J., *Tappi* 41, No. 3, 170–190 (March, 1957).
4. Jayme, G. and Lochmuller-Kerler, E., *HolzRoh u. Werkstoff* 6, 274–277 (1943).
5. Nolan, W. J., *Tappi* 44, No. 7, 484 (July, 1961).
6. Nolan, W. J., *Tappi* 41, No. 10, 567–581 (October, 1958).
7. Hägglund, E., "The Chemistry of Wood," p. 202, New York Academic Press, Inc., 1951.
8. Marriner, D. E. and Whitney, R. P., *Tech. Assoc. Papers* Series 31, 143–145 (1948).
9. Smith, J. M., "Introduction to Chemical Engineering Thermodynamics," p. 70, New York, McGraw-Hill Book Co., 1949.

RECEIVED May 31, 1961. Presented at the meeting of the A.I.Ch.E., held in Cleveland, Ohio, May, 1961.

Decolorizing Studies on Arabogalactan from *Larix occidentalis* Nutt.

KURT H. EKMAN

Freundlich adsorption isotherms of some active carbons have been determined for phenols in arabogalactan solutions obtained from western larch (*Larix occidentalis* Nutt.). The calculation of the rate of decolorizing is based on the capacity of the phenols to reduce Folin-Denis reagent. From the adsorption isotherms obtained, it appears that some phenols are noncompatible in occupying active centers of different carbons. It is noticed that an increasing rate of adsorption is associated with decreasing pH of the solution. Compared to the crude arabogalactan, the decolorized product shows altered properties, both chemical and physical.

THE *larix* genus represents an abundant and uniform source for obtaining the water-soluble polysaccharide arabogalactan, which can be used as a gum of low viscosity and high solids dispersing power. Hence, it is not surprising that many attempts have been made to commercialize this polysaccharide. Acree (*1*) has described the extraction of larchwood for commercial evaluation but he was interested only in obtaining mucic acid by hydrolyzing the arabogalactan and oxidizing the D-galactose. Later Clapperton (*2*), and also Austin (*3*), prepared pilot-plant quantities. But arabogalactan never has been produced commercially.

Since 1958, the problem of utilization of the arabogalactan from *Larix occidentalis* Nutt., the western larch, has been studied at the Division of Industrial Research of Washington State University, and an economical leaching process has been developed. The present work was undertaken to supplement and extend this project to include the removal of colored impurities in order to improve the properties and widen the field of possible commercial application of arabogalactan.

Whistler, *et al.* (*4*), have summarized a part of the fairly extensive literature on arabogalactan from different species, up to 1954; but much of interest has happened since then (*5, 6*). It may be well to emphasize the fact that the colored impurities are not easily removed from an arabogalactan extract. These difficulties are shown convincingly by Chesnokov (*7*), who tried to decolorize an extract from Siberian larch. The tenacious retention of impurities by the polysaccharide made these attempts unsuccessful because the agent used was not sufficiently active [carbon (cf ref. *8*) and plant fiber], too injurious (sulfur dioxide), technically impractical (aluminum and magnesium oxides), or too costly (alcohol).

Although many authors (*9, 10, 11*) have subjected alcohol-purified arabogalactan to exhaustive structure studies, extensive laboratory experiments here have shown that highly pure arabogalactan cannot be obtained by a simple or partial precipitation of the polysaccharide extract by alcohol. Among the agents which have been used in attempts to purify arabogalactan, lead acetate–tannic acid (*9*) and ion-exchange resins are worthy of mention. Bouveng and Lindberg (*5*) filtered an arabogalactan extract from western larch through ion-exchange columns, but the polysaccharide obtained was still a light-colored powder on precipitation with ethanol. Electrodialysis of arabogalactan solutions also has been tried (*12, 13*).

Preliminary investigations performed by the author (*14*) using chromatographic techniques, show that the tan-colored impurities of an arabogalactan extract from western larch are mainly phenolic in character.

In the present study, the decolorizing of arabogalactan solutions using active carbon is discussed.

EXPERIMENTAL

Extraction of Larchwood

Before chipping of the larchwood, all bark was carefully removed because color bodies from residual bark have a great influence on the final color of the extract (*3*). The larchwood chips were extracted in a countercurrent leach system developed in this laboratory by Dr. M. F. Adams (*15*). The operation was performed as a cold water cycle—at room temperature—in a system operated on a pilot-plant scale. The aqueous extract was drum-dried. The arabogalactan so obtained had an ash content of 0.3% and an arabogalactan content of approximately 97%.

KURT H. EKMAN, Research Chemist, Division of Industrial Research, Washington State University, Pullman, Wash.

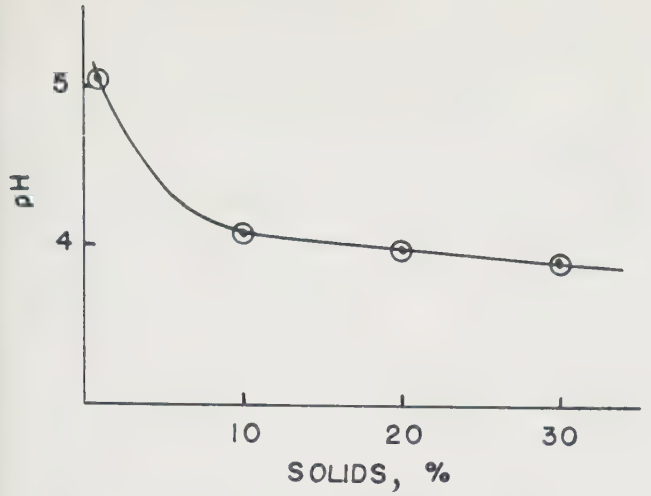


Fig. 1. The pH of arabogalactan solutions

The Arabogalactan Solution

Drum-dried arabogalactan obtained from a leach solution containing 15% solids was redissolved in distilled water to give solutions of 1, 10, 20, and 30% concentration. The pH of these tan-colored solutions is given in Fig. 1.

Recently Nazareth, *et al.* (*16*), reported some physical properties of solutions or redissolved arabogalactan.

The Active Carbons

Fifteen commercial active carbons were tried but only those four listed in Table I were selected as representative of specific types of carbon compared with regard to the adsorption efficiencies. They are identified by numbers rather than names. Powdered carbon no. 1 was chosen as the reference carbon because of its high adsorption efficiency in the acidic arabogalactan solutions.

The grinding specifications for the carbon required that about 95% of the powdered carbon pass a 100-mesh screen and about 65 to 75% pass a 325-mesh screen.

The moisture and the ash content of the carbons were determined according to Hassler (*17*), and the pH according to Honig (*18*).

To determine the amount of inorganic substances extractable by water, 10 g. of carbon was digested with 50 ml. distilled water for 20 min. at 80°C., the filtrate was evaporated and the residue weighed.

Determination of Color

For the selection of a reference standard, considerable work was done to get an optically clear solution for the determination of the absorbency without any appreciable modification of the basic color. While the method of preparing such a solution is still not settled, the determination of the rate of adsorption was performed on the basis of color developed with the Folin-Denis reagent (*19*).

The analytical procedure for determination of phenols in untreated as well as activated carbon treated solutions was as follows:

A solution of 2.5 ml. of the Folin-Denis reagent, a standardized aliquot of an arabogalactan solution and 13 ml. of a 20% sodium carbonate solution were diluted to 100 ml. in a 100-ml. volumetric flask. The volumetric flask was then kept in a constant temperature bath for 30 min. at 30°C. and the absorbency was immediately recorded at 720 mμ.

In order to compare the unknown relative amounts of phenols, the standardized aliquot of arabogalactan solution was chosen in each analysis to contain 125 mg. arabogalactan per 100 ml. solution. The usual absorbency of such an untreated solution was between 0.690 and 0.720. This absorbency, a, represented the original color concentration of 100% or C_0 as 100 color units, and the absorbency a_2 of carbon-treated solutions was used to express the color units C left after such a treatment. The color units X adsorbed or the percentage decolorization is therefore $(C_0 - C)$.

The Beer-Lambert law was found to apply for phenolic impurities in arabogalactan solutions of different concentrations. The curve did not deviate from a straight line for solutions of impure arabogalactan containing 10 to 150 mg. of solids per 100 ml. of solution.

All measurements were made using a Beckman DU spectrophotometer. Distilled water was used as a blank.

The Folin-Denis method seems to be more advantageous than a method that would measure directly the absorbency of the solutions, since the blue color developed with alkaline Folin-Denis reagent is independent of the pH of the solution itself.

Table I. Properties of Active Carbons

No.	*Moisture, %*	*Ash, %*	*Water soluble, %*	*pH*
1	2.25	0.55	0.02	5.62
2	3.34	3.15	0.02	7.30
3	4.83	4.39	1.33	6.48
4	10.36	3.77	2.81	2.08

Analytical Procedure

The technique used to determine the decolorizing efficiency of the active carbons has already been developed for technical purposes by Sanders (*20*), and is based on Freundlich's empirical adsorption equation $X/M = KC^{1/n}$.

In decolorizing arabogalactan solutions, active carbon no. 1 was applied to solutions of varied viscosities, and the temperature and time of contact required to reach the most favorable adsorption equilibrium was determined. It was observed that at a standard temperature of 80°C. the adsorption was extremely rapid, even for a 30% solution of higher viscosity. Thus, after 15 min. the adsorption gradually reached a point where increased time of contact resulted in no further decolorizing. Assuming that the optimum conditions were the same for all carbons listed in Table I, the following laboratory precedure was adopted:

A volume of 50 ml. of an arabogalactan solution of known solids concentration was treated with activated carbon (calculated on a moisture-free basis) in increasing quantities; i.e. to the first solution was added 1% carbon on solids, to the second 5%, then 10%, then 20%, and so on. The solution was stirred vigorously for 20 min. at 80°C., if not mentioned otherwise. Before the carbon was filtered off using a Büchner funnel, the solution was cooled to room temperature. In order to obtain a clear filtrate, the solution had to be filtered at least three times through the same filter. Pressure filtration was also performed with success.

The amount of phenolic impurities in the untreated and treated solutions were then measured at 720 mμ using alkaline Folin-Denis mixture as a dyestuff developing reagent.

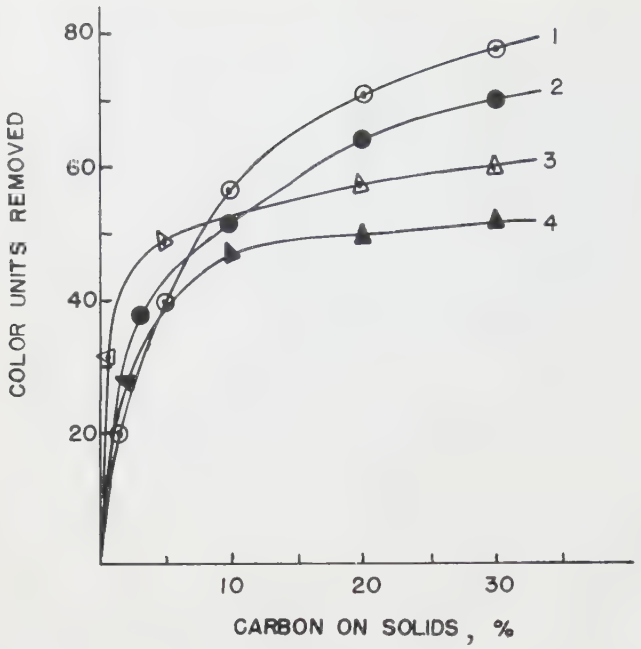


Fig. 2. Decolorization isotherms; 10% arabogalactan solution

Color units removed, or per cent decolorization vs. percent carbon (Table I)

DISCUSSION OF RESULTS

The Folin-Denis colorimetric method used in the present study does not measure the actual molecular concentration of the phenols in an arabogalactan solution. Based on color units, this procedure compares the capacity of the phenols to produce the molybdenum blue by reduction of the reagent before and after carbon treatment. Although some errors may arise from differences in adsorption by active carbons of phenols with different reduction ability, this indirect procedure seems to be acceptable to obtain the adsorption characteristics of different carbons. Other known noncarbohydrate compounds of arabogalactan solutions do not interfere in these determinations.

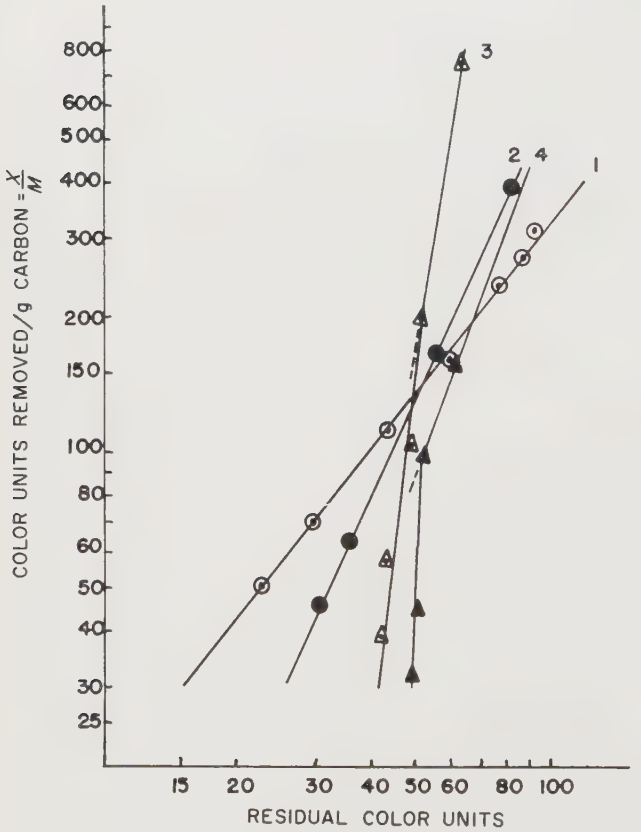


Fig. 3 Decolorization isotherms; 10% arabogalactan solution

Color units removed per gram of carbon (Table I) vs. residual color concentration. Original color taken as 100 units.

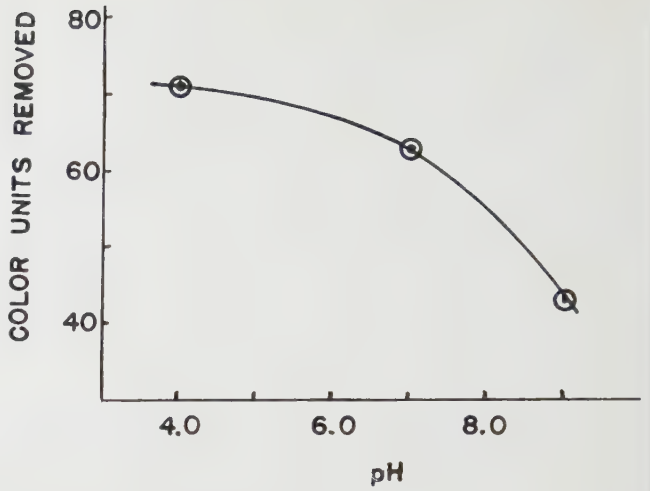


Fig. 4. The adsorption of phenols as a function of pH

10% arabogalactan solution. 20% no. 1 carbon based on solids.

The relative nature of measurements of the adsorption using the active carbons listed in Table I is illustrated in Fig. 2. Freundlich adsorption isotherms were obtained from measurements on a standard 10% arabogalactan solution. The carbon dosage, M, was plotted versus the Folin-Denis color units, X, removed when the temperature, the time of contact, and the concentration were all constant. An inspection of these isotherms shows that the active centers* of the carbons are fairly different. With successive equal increments of the carbons these centers cause a gradually different diminishing adsorption calculated on the basis of Folin-Denis color units.

* The term active centers is broadly defined here as the sum of the forces by which adsorbed molecules are attached to a heterogeneous surface of active carbons.

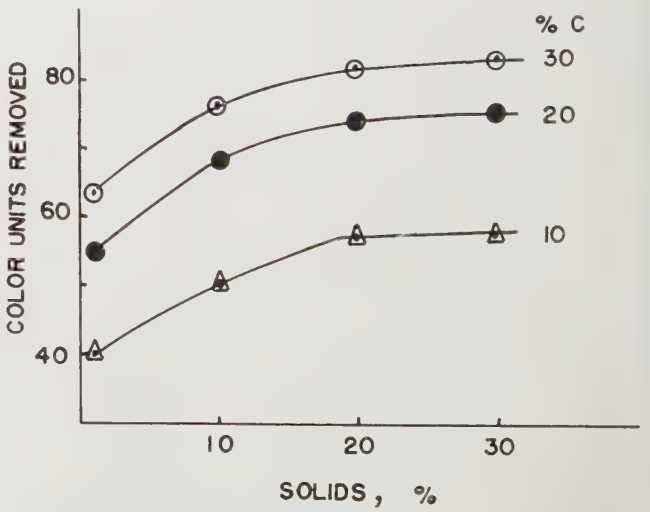


Fig. 5. The adsorption of phenols as a function of the concentration

The curves represent 10, 20, and 30% carbon (no. 1) on solids; i.e., curves of constant carbon.

Table II. Properties of Arabogalactan

	Crude[a]	*Decolorized*[b]
Solid		
Color	Tan	White
Flavor	Wood flavor	None
Ash	0.29	0.30
30% Solution		
Color	Dark-tan and turbid	Colorless and clear
Flavor	Wood flavor	None
pH	3.90	3.74[c]
Viscosity, cp[d]	8.05	7.65
Phenol reagent		
Folin-Denis	100 color units	11.8 color units
$FeCl_3$	Strongly positive	Almost negative
Color in NaOH	Dark-brown	Slightly yellow
$[\alpha]_D^{20}$	...	+12.32°

[a] Isolated by drum-drying.
[b] The active-carbon treated arabogalactan was isolated by freeze-drying.
[c] The pH of a 30% solution of redissolved, alcohol-precipitated arabogalactan was 5.8.
[d] Measured with an Ostwald viscometer at 20 ± 0.05°C.

Another more distinct way of detecting qualitative as well as quantitative differences between active carbons is to follow Freundlich's equation in its logarithmic form. Here, Folin-Denis color units removed per gram of carbon, X/M, are plotted versus residual color concentration C on logarithmic paper. Figure 3 shows that the active carbons form two groups, one group represented by a straight-line adsorption isotherm (nos. 1 and 2), and another group that fails to obey Freundlich's equation. Group two deviates more or less in the region of higher carbon dosages, i.e., lower residual reducing concentrations of the solutions (no. 3 and 4). This deviation probably is caused by the variable adsorption of the different phenols in the arabogalactan solutions. According to Helbig (*21*) it would appear that below the break in the curves of Fig. 3 are compounds which are noncompatible and cannot occupy the active centers of the carbon.

The intersections of the isotherms represent points of equal adsorption efficiencies. A steeper slope (nos. 2 to 4) above the intersection would indicate more, and below less adsorption efficiencies compared with a slope that corresponds to a smaller $1/n$ value (no. 1). In industrial counter-current operations this means that the first mentioned carbons would have more reserve power and thus would be more useful. Nevertheless, experiments showed that the two carbons which failed to obey Freundlich's equation were without counter-current capacity at lower residual reducing concentration of the solution. This, probably, was because of the already mentioned nonadsorbable character of some phenols by the activated carbon.

Since carbon no. 2 tended to peptize in an acidic arabogalactan solution, only carbon no. 1 was found useful in a single as well as counter-current decolorization. Because of these facts carbon no. 1 was chosen as a standard.

To obtain an interpretation of the separate and combined influences of the pH and concentration, the isotherms in Figs. 4 and 5 were developed for the standard carbon, no. 1. Thus, concerning the adsorption efficiency at different pH, the isotherm in Fig. 4 shows a decreasing adsorption efficiency with increasing pH of the solution, in agreement with data presented by many authors (*22, 23*).

The adsorption of phenols as a function of the concentration expressed in Folin-Denis units is shown in Fig. 5. The increasing rates with the concentration are seen to be determined mainly by changes in the acidity as a consequence of increasing amount of substances; i.e., arabogalactan with its acidic impurities (Fig. 1). Even though a more acid condition aids the adsorption, addition of acid (e.g., acetic) to the arabogalactan solution is not recommended because this excess of acid would be difficult to remove.

Considering any action on the arabogalactan itself by active carbon no. 1 possessing acidic properties, experiments performed showed that there occurs neither a marked adsorption nor a hydrolyzing effect.

Finally, experimental difficulties arose in attempting to determine the purity of arabogalactan treated with active carbon, because the amounts as well as the structure of the different impurities such as colored phenols and acids in the starting material still are unknown. A comparison of the contrasting properties of the crude arabogalactan and those of the carbon-treated product set forth in Table II indicate, however, that a great improvement of the properties of flavor, color, and clarity was reached. It can be pointed out here, that the infrared spectra of these two arabogalactan preparations were compared and found to be identical because of the small amounts of compounds other than arabogalactan which were present.

LITERATURE CITED

1. Acree, S. F., U. S. pats. 1,816,135; 1,816,136; 1,816,137 1,816,137 (1931) and 2,073,616 (1937).
2. Clapperton, E. C., *Western Pine Assoc. Research Note* No. 1–5121 (1953).
3. Austin, G. T., *J. for Prod. Res. Soc.* 4, No. 1: 7 (1954).
4. Whistler, R. L. and BeMiller, J. N., "Industrial Gums," page 307, New York and London, Academic Press, 1959.
5. Bouveng, H. and Lindberg, B., *Acta Chem. Scand.* 10: 1515 (1956); *Acta Chem. Scand.* 12: 1977 (1958).
6. Bouveng, H., *Acta Chem. Scand.* 13: 1869, 1877 (1959).
7. Chesnokov, F., *Lesokhim. Prom.* 3: 8 (1940), 9; *CA* 37, 2607.
8. Wise, L. E. and Peterson, F. C., *Ind. Eng. Chem.* 22: 362 (1930); White, E. V., *J. Am. Chem. Soc.* 64: 2838 (1942).
9. Wise, L. E., Hamer, P. L., and Peterson, F. C., *Ind. Eng. Chem.* 25: 184 (1933).
10. White, E. V., *J. Am. Chem. Soc.* 63: 2871 (1941).
11. Tsveta'eva, J. P. and Mercur'eva, A. V., *J. of Appl. Chem. U.S.S.R.* 32: 2783 (1959).
12. Elder, A. L., Easton, R. P., Pletcher, H. E., and Peterson, F. C., *Ind. Eng. Chem., Anal. Ed.* 6: 65 (1934); Peterson, F. C., Maughan, M., and Wise, L. E., *Cellulosechem.* 15: 184 (1934).
13. Adams, G. A., *Can. J. of Chem.* 38: 280 (1960).
14. Ekman, K. H., "Purification Studies on Crude Arabogalactan," Unpublished research, Wash. State Univ., D.I.R. (1961).
15. Adams, M. F., personal communication. U. S. pat. application S.N. 37,445 (June 20, 1960).
16. Nazareth, M. R., Kennedy, C. E., and Bhatia, V. N., *J. of Pharmaceutical Sci.*, 50. No. 7 (July) 1961, in press.
17. Hassler, J. W., "Active Carbon," page 355, New York, Chemical Publishing Co., Inc., 1951.
18. Honig, P., "Principles of Sugar Technology," page 423, Amsterdam, Elsevier Publishing Co., 1953.
19. Folin, O. and Denis, W., *J. Biol. Chem.* 22: 305 (1915); Snell, F. D. and Snell, C. T., "Colorimetric Methods of Analysis," 3rd ed., vol. 3, pages 104 and 116, New York, D. Van Nostrand Co., Inc., 1953; Halmekoski, J., *Suomen Kemistilehti* B 32: 274 (1959).
20. Sanders, M. T., *Ind. Eng. Chem.* 15: 784 (1923); *Ind. Eng. Chem.* 20: 791 (1928).
21. Helbig, W. A., in Alexander, J., "Colloid Chem.," vol. 6, page 814, New York, Reinhold Publishing Corp., 1946.
22. Blowski, A. A. and Bon, J. H., *Ind. Eng. Chem.* 18: 32 (1926).
23. Hauge, S. M. and Blowski, J. J., *Ind. Eng. Chem.* 19: 943 (1927); Hess, G. and Santer, O., *Naturwissenschaften* 34: 251 (1947).

Received June 22, 1961.

This investigation has been supported by funds provided by J. Neils Lumber Co., Libby, Mont., a subsidiary of St. Regis Paper Co. of New York, N. Y., and by the Finnish Academy, Helsingfors, Finland.
The author is indebted to Mrs. Carol Douglas, for technical assistance.

Measurement of the Relative Molecular Weight of Lignosulfonates by Diffusion

I. Methods for Molecular Weight Determination and for Separation of Interfering Substances by Ion Exclusion or by Exhaustive Dialysis

JULIUS BENKO

A method for determination of relative molecular weight of complex, water soluble mixtures of lignosulfonates and other wood-derived components has been developed and found to be reliable and reproducible. Small scale diffusion of water soluble lignosulfonates is carried out in durable, low cost, glass diffusion cells developed for this purpose. Samples of 0.5 g. or less are used in a cell of about 150 ml. total volume, and the results are measured in terms of optical density at 281.5 mμ. In order to obtain reliable molecular weight information by means of diffusivity measurements one or more simple steps of fractionation are usually necessary. Fractionation by means of ion exclusion separates the low-molecular-weight components up to molecular weight of about 50, completely. Absolute molecular weights up to 25,000 (relative molecular weight 60,000) have been measured on ion excluded samples. Exhaustive dialysis through cellophane accomplishes a sharper and more complete removal of the low-molecular-weight lignosulfonates from the samples. Relative molecular weights of 10,000 to 100,000 have been measured on lignosulfonates thus fractionated. Description of the diffusivity measurement technique, fractionation by means of ion exclusion and by means of cellophane diffusion is the subject of this first paper. Presentation of experimental data is given in succeeding papers in this series.

KNOWLEDGE of the average molecular weight is always important when working with polymeric substances. However, in some cases the determination of the average molecular weight is a very complicated problem. This is particularly so when the substance in question cannot be sufficiently purified, since the results of the conventional molecular weight methods are altered, by the presence of a small percentage of low molecular-weight impurities, to such an extent that they become meaningless. Even with careful and tedious fractionation steps, the polyelectrolyte nature of the lignosulfonates excludes the use of any method which is based upon the measurement of the particles of various degrees of ionization which are present in solution.

Molecular weight determination by means of diffusivity measurements came into use in the 1930's and a few years later the first attempts to use this method for the determination of the molecular weight of lignosulfonates were made by G. Jander, *et al.*, K. Schwabe, *et al.*, and D. Pennington, *et al.* (*1–3*). Molecular weight determination of lignosulfonates by diffusivity measurements offers an obvious advantage over many other methods since it is not interfered with by the presence of the usual inorganic components of the spent sulfite liquor, by the presence of the usual carbohydrate materials, nor by the usual salts of formic and acetic acids. Thus the relative molecular weight values can be measured by the diffusion method with an appropriate experimental technique which takes into account the peculiarities, and in particular, the polyelectrolyte nature of lignosulfonates. Whether such values actually represent molecular weights or molecular dimensions is open to question. Molecular weight is the term generally used for the characterization of molecules, and since this term has been used by previous workers, it also is used here, with the above reservation in mind.

It has been found repeatedly by the author, as well as by others, that such relative molecular weight values confirm expectations based upon general physicochemical knowledge, and such information is useful for the characterization of lignosulfonates. Diffusivity measurements as a method for the molecular weight determination of lignosulfonates would probably long since have become more widely accepted had it not been for the interference of low-molecular-weight organic materials most of which probably are derived as decomposition products from both carbohydrates and lignin.

Materials such as furfural, hydroxymethylfurfural, and monomeric lignin degradation products are found to interfere, sometimes to a pronounced extent, with the optical density reading of lignosulfonates at 281.5 mμ. Therefore, this highly convenient analytical method for lignosulfonates cannot be applied in many cases without a prior separation of the interfering molecules. Analysis through the methoxyl groups, as an alternative, would call for much larger diffusion apparatus, more complicated analytical procedure, and is further complicated by the fact that the distribution of methoxyl groups in the different lignosulfonate fractions is probably not uniform. Thus the general applicability of the diffusion method for the molecular weight determination of lignosulfonates depends upon a successful and not too complicated separation of low-molecular-weight organic substances which interfere with the optical density readings of the lignosulfonates at 281.5 mμ. Although only minor quantities of these interfering substances are usually present in the spent sulfite liquor, owing to their comparatively high diffusion rates, they are apt to lower the relative molecular weight values of

JULIUS BENKO, Lignin Chemist, Sulphite Pulp Manufacturers' Research League, Appleton, Wis.

lignosulfonates to a very large extent unless they are removed prior to diffusivity measurements.

For the separation of the interfering organic substances, the usual methods of steam distillation and solvent extraction were tried first, but results were either not successful or only partially so. Ion exclusion provides a good separation of all interfering, small organic molecules up to a molecular weight of about 500 to 600. Simultaneously, a somewhat overlapping fractionation of the lignosulfonates is also accomplished.

Exhaustive dialysis through an appropriate membrane provides a much sharper fractionation than ion exclusion. Exhaustive dialysis through cellophane removes not only the small organic molecules other than lignosulfonates but also the smaller lignosulfonate molecules, and leaves only molecules larger than relative molecular weight of about 10,000 in the undiffused material.

Experimental data in the second part of this publication show that combination of these steps, removal of low-molecular-weight substances and diffusivity measurements on the remaining fraction, are well adapted to demonstrate the changes of lignosulfonates during the cooking process as well as during subsequent treatments.

EXPERIMENTAL

Determination of the Relative Molecular Weight of Lignosulfonates by Means of Diffusivity Measurements

Apparatus. The diffusion cell is built around a sealing tube with a medium porosity fritted disk in its center (Pyrex catalog no. 39570), and has provisions for easy filling and emptying of both of its chambers. For checking the porosity of the fritted disk a good rule of thumb is that a 1-in. high column of water at atmospheric pressure should flow through the disk in 4 to 8 min. Should it take much less time, free flow is likely to interfere with the diffusion. The volume of each chamber is about 70 ml., but this is not critical since volume differences are easily corrected for by calculation. It is therefore not necessary to employ highly precise and expensive construction to obtain close duplication in volume between different diffusion cells. Problems related to the construction of diffusion cells, and a few examples, are presented by Geddes (*4*), along with a number of literature references. Among other things, the importance of proper pore size of the membrane is discussed.

Stirring during the diffusion is accomplished by means of a small pellet moving through the liquids in each of the chambers while the cell is in a slow, continuous rotating motion. These stirring pellets are constructed from a material softer than glass, because continuous friction of glass pellets against the fritted disk may have, over a period of time, a considerable polishing effect eventually resulting in continuous changing of the diffusion characteristics of the cell. Therefore, plastic materials of good chemical resistance, such as Teflon, are used for the stirring pellets. The diffusion cells are mounted on a frame with a 12-in. radius and rotated vertically about a horizontal axis in a constant temperature room at 25°C. at about one r.p.m. by a belt-and-pulley mechanism during the entire period of diffusion.

Standard KCl Solution

The choice of a suitable standard for the calibration of the diffusion cells presents a problem. A lignosulfonate model substance or a simple organic compound, such as vanillin, coniferyl aldehyde, or an indicator dye such as methyl orange or congo red could be used. However, it was decided to follow A. R. Gordon (*5*), who has previously used the diffusion method for lignosulfonates, and use a 0.1*N* KCl solution for the standard. It is realized that the use of the KCl standard solution does result in relative molecular weights of about 2.5 times the actual values for vanillin and furfural, as well as for a number of other simple organic compounds (see Experimental, Example V in Part II.). This disadvantage is outweighed by the benefits of having a standard which gives figures directly comparable with those of other workers who have been using diffusion measurements on lignosulfonates. The change of the standard later on would result in changes of the numerical values, but not in their relationship to one another.

The potassium chloride diffusion coefficient is measured as follows: First, the diffusate side of the diffusion cell and the pores of the fritted disk are filled with distilled water. The latter operation is accomplished by allowing free flow of distilled water through the disk. Next, the stopcocks on the diffusate chamber are closed and the water from the sample chamber is shaken out. The sample chamber is rinsed first and then filled with 0.1*N* KCl. An initial, 3- to 4-hr. period of diffusion is then conducted in the constant temperature room at 25°C., under slow rotation. During this conditioning period an equilibrium concentration will be established in the fritted disk, corresponding to the concentrations on both sides of the disk.

At the end of the conditioning period, the distilled water in the diffusate chamber is changed and the diffusion period proper begins. The necessary length of the diffusion period depends largely upon the analytical technique used in measuring the amount of the diffusate. Using the silver nitrate titration method for chlorides (with potassium chromate as indicator) a diffusion period of more than two days is allowed, but when using the spectrophotometric potassium determination an overnight diffusion period is sufficient.

At the end of the diffusion period the contents of both chambers are emptied into tared dishes and the volume of each chamber is established by weight. For practical purposes the specific gravity of the 0.1*N* KCl may be neglected, and thus the volume correction factor of the cell may be directly established from the ratio of the two weights.

Calculations

The concentration of KCl in both chambers is determined next, the original sample concentration is recalculated, and finally the diffusion coefficient, λ_{KCl}, is calculated from the equation:

$$\lambda_{KCl} = \frac{\log c_0 - \log c_t}{\text{time (days)} \times \log e} \qquad (1)$$

where c_0 = initial concentration of sample,
c_t = final concentration of sample at end of experiment,
e = base of the natural logarithms (2.718).

In the case of one of our diffusion cells, Cell A, experimental data were as follows:

Content of sample chamber.....64.2213 g.
Content of diffusate chamber.....65.5613 g.

$$\text{Volume correction factor} = \frac{65.5613}{64.2213} = 1.023$$

11.82 ml. of 0.1N $AgNO_3$ has been used for 15 ml. of sample chamber
3.23 ml. of 0.1N $AgNO_3$ has been used for 15 ml. of diffusate chamber length of diffusion = 2.771 days

$$\text{Thus, } \lambda_{KCl} = \frac{\log 15.12 - \log 11.82}{2.771 \times 0.43428} = \frac{1.17955 - 1.07262}{1.2034} = 0.08885$$

Note: $15.12 = 11.82 + (1.023 \times 3.23)$.

In the above calculation, as a practical shortcut, the volumes of reagent have been used instead of the concentration. These are equivalent as long as solutions are not changed during the course of the same experiment.

The diffusion of the material of unknown molecular weight, whether a nonelectrolyte or an electrolyte with anions and cations of equal mobility, would be performed in the same way as described above. Lignosulfonates, however, are anionic polyelectrolytes consisting of very large and thus relatively slow-moving anions, and their salts are formed with much smaller and much more mobile cations. Diffusion of such molecules in distilled water would result in establishing of electrical potentials across the frit by the faster moving cations, consequently, relative molecular weight values measured would be too low. This phenomenon is compensated for by using a strong electrolyte, such as 0.1N KCl as the solvent for the sample as well as the medium into which the diffusion progresses.

The concentration of the lignosulfonate samples for diffusivity measurements may be varied between wide limits without having any bearing upon the results; but it is more convenient to use a concentration which will give sufficient diffusate for a reliable optical density reading during the course of an overnight diffusion period. Variation of the relative molecular weight values due to much higher or much lower sample concentrations than suggested has been briefly investigated. It has been found that concentrations five times lower or higher do not significantly change the results. However, the lower concentration might require a longer diffusion period, whereas a higher concentration may require dilution of the diffusate preceding the optical density reading.

The concentration of lignosulfonates is established by means of optical density reading at 281.5 mμ with a 0.3 slit on the Beckman DU spectrophotometer, assuming that the reading originates from lignosulfonates only. To avoid interference in the optical density reading by other substances, fractionation, and thus removal of the interfering substances, has to precede the diffusivity measurement. To this end, fractionation by means of ion exclusion and by means of exhaustive dialysis through cellophane have been employed, as discussed below.

At the end of the diffusion period, which is preceded by a conditioning period of a few hours, the optical density is read for both chambers; the original concentration is calculated for the sample chamber, and the diffusion coefficient from equation (1).

As an example, the following data have been obtained from Cell A:

Time of diffusion, 19 hr. 20 min., or 0.805 days
Concentration in the sample chamber at the end of the experiment (read after a 1 in 100 dilution, 281.5 mμ), 0.336
Concentration in the diffusate chamber at the end of the experiment (read without dilution, 281.5 mμ), 0.196
Therefore

$$\lambda = \frac{\log 33.8005 - \log 33.600}{0.805 \times 0.43428} = \frac{1.52892 - 1.52634}{0.3496} = 0.00738$$

Note: $33.8005 = 33.600 + (1.023 \times 0.196)$.

The relative molecular weight of the lignosulfonate sample is then calculated from the equation:

$$MW_1 = \left(\frac{\lambda_2}{\lambda_1}\right)^2 \times MW_2, \qquad (2)$$

$$\text{thus } MW_{\text{lignosulfonate}} = \left(\frac{0.08885}{0.00738}\right)^2 \times MW_{KCl} = 10{,}900$$

As shown in the above example, the relative molecular weight of the lignosulfonate material has been calculated from the diffusion characteristics of less than 1% of the sample optical density. Admittedly, it would be preferable to base the calculation upon the diffusion characteristics of a larger proportion of the material.

In an attempt to allow more material to diffuse in the same length of time, a diffusion cell with larger-than-usual pore size has been constructed. This cell, however, was found to be useless for diffusivity measurements, since free flow through the pores interfered to a remarkable extent with the diffusion. The author has been informed by other workers of similar unsuccessful attempts in obtaining larger percentages of sample material through a membrane in a short period of time. It appears that in all such cases there is an interference with the diffusion by other phenomena. Thus, it seems that the percentage of sample material obtainable in the diffusate without an evident interference in the diffusion process is limited.

Being apparently limited in the choice of pore size, other ways of increasing the amount of diffusate would be to increase the temperature or to allow longer diffusion periods. Both alternatives are impractical for routine work. To double the amount of the diffusate by increasing the temperature, the diffusion would have to be performed at around 65°C. Alternatively, to obtain 20 to 30% of the total optical density in the diffusate by increasing the diffusion time, more than a month would be necessary at 25°C.

On one occasion such a lengthy diffusion experiment was performed on a solvent-extracted, high-molecular-weight material. Some 40% of the total optical density was diffused, but the relative molecular weight of the sample remained practically unchanged, showing only a slight increase. If the experiment had been carried further, the increase might have become more significant, but the experiment has definitely indicated that variations of the diffusion period, in the order of a few days, do not influence the relative molecular weight values.

Because of the findings discussed above, a standardized procedure of calculating relative molecular weights from the diffusion characteristics of a small proportion of the sample material was adopted. Fractionated sample materials are used, and thus gross interference by small molecules is avoided. There is, however,

interference to some extent in all diffusivity measurements by the lower-molecular-weight components in any particular mixture.

Finally, a few rather obvious but important experimental details are pointed out. Careful washing of the diffusion cells, including the pores of the frit, with distilled water is necessary to avoid contamination of the sample. Periodic cleaning of the cells with acid bichromate solution every six weeks, or whenever indicated, helps to keep the frit free from deposits of mold growths. To minimize possible microbiological reactions, it is preferable to have a few parts per million of mercuric chloride added to the 0.1*N* KCl solution. It also is preferable to prepare large amounts of 0.1*N* KCl solution with the mercuric chloride added rather than to prepare such solutions individually for each sample.

Fractionation of the Spent Sulfite Liquor by Ion Exclusion

Ion exclusion is a unit operation in which, according to the original concept, the ionized and nonionized particles of an aqueous solution are separated while operating conventional ion-exchange resin beds in a particular way. Basic information about theory and application of ion exclusion was published by Wheaton, *et al.* (*6*), and a short outline of a typical operating method and further references are contained in the Dowex Ion Exchange booklet (*7*).

Felicetta, *et al.* (*8*), published information indicating that low-molecular-weight lignosulfonates may be separated from those of larger molecular weight by means of ion-exclusion technique. It is known that the separation of the different components of a mixture by this technique is not necessarily due to ion exclusion alone, but is rather the result of a number of phenomena taking place simultaneously while the resin bed is used in a particular way. Besides that of ion exclusion, such important phenomena are continuous diffusion, adsorption–desorption and molecular sieve action. In connection with these phenomena, we find that not only the ionic and nonionic nature affect the results, but the molecular size of the particles to be separated also becomes an important factor. Assuming ion exclusion alone to be responsible for all separations by this technique, it is difficult to explain why a mixture of the sodium salts of the indicators congo red, bromothymol blue and methyl orange distinctly separates on a Dowex 50*W* ×2 resin bed, which is also in sodium salt form. Furthermore, why do these indicators appear in the above order in the effluent, the order being that of their molecular weights, the highest molecular weight appearing first. The term "ion exclusion" is therefore employed in this paper for the description of a particular way of operating a resin bed, in which operation it is not intended to obtain ion exchange, but rather to achieve particle separation on the resin bed by utilizing all the above-named phenomena concurrently. The term "ion exclusion" should not mislead or suggest that separation of particles by this technique is due to ion exclusion alone.

To achieve good separation of the components of a mixture in aqueous solution by means of ion exclusion, the choice of an appropriate ion-exchange resin is important (*6–8*). An equally important factor is the proper shape of the resin bed, which should have a smaller diameter in relation to length than for ion-exchange operation. Maintenance of appropriate operating conditions such as low rate of flow and a high ratio of resin-to-sample is necessary. Dimensions, suggested capacities for good fractionation, and suggested flow rates for two different columns are given in Table I. Dowex 50*W* ×2 resin in sodium form and of a 50 to 100-mesh size has been used.

Table I. Suggested Operating Conditions for Ion-Exclusion Columns

	Column A	*Column B*
Height, mm.	1000	1200
Inside diameter, mm.	9	30
Ratio of diameter to height	1:111	1:40
Approx. vol. of resin, cc.	45	800
Suggested flow speed, front of the sample, mm./hr.	400	400
Suggested capacity (amount lignin solids to feed for good fractionation), g.	0.5	5

Under the operating conditions of ion exclusion, regeneration of the resin bed between the operating cycles is not necessary, since the resin remains in the same form during the whole operation. However, careful washing of the resin bed with large amounts of water is very important, because some components of the spent liquor, usually present in minor quantities, remain much longer on the resin bed than the bulk of the fractionated material, and unless carefully eluted, may cause cross-contamination during the next ion-exclusion cycle. Backwashing of the resin bed helps to avoid channeling and also keeps the resin bed in a loose, not unduly compressed, state. After a number of ion-exclusion cycles the resin bed is converted to the acid form with diluted hydrochloric acid, the resin is washed while in the acid form, then converted to the sodium salt with sodium hydroxide, and finally washed until the effluent is neutral. During this cyclic operation, minor quantities of impurities, otherwise not removed, are eluted from the resin bed.

Neutralized sodium salts of the sample are used for ion exclusion at about 30% solids concentration. Lignosulfonates which contain appreciable amounts of cations other than sodium are first converted to hydrogen form on an Amberlite IR 120 resin bed operated on the hydrogen cycle, and the free acids are neutralized with sodium hydroxide. Concentration of the sample is done under reduced pressure. The inorganic content of the sample may be greatly reduced if concentration is performed on the free acid material, since practically all free sulfur dioxide can be boiled off from the sample.

Following these preparatory steps, the sample is placed on the resin bed while carefully avoiding any dilution, since excessive dilution at this stage reduces the useful path length for ion exclusion. While the mixture passes slowly downward in the column followed by distilled water, the flow speed is adjusted as suggested in Table I. The combination of diffusion, adsorption–desorption, and ion exclusion phenomena then take place. The sum of these unit operations enables the collection of a fractionated material in the effluent.

Column A is used to prepare two fractions only and to supply sufficient sample material for a single diffusivity measurement. The first fraction, in which the first 16 ml. of the colored effluent are collected, contains some 70 to 80% by weight of the sample, and is used for relative molecular weight determination. The

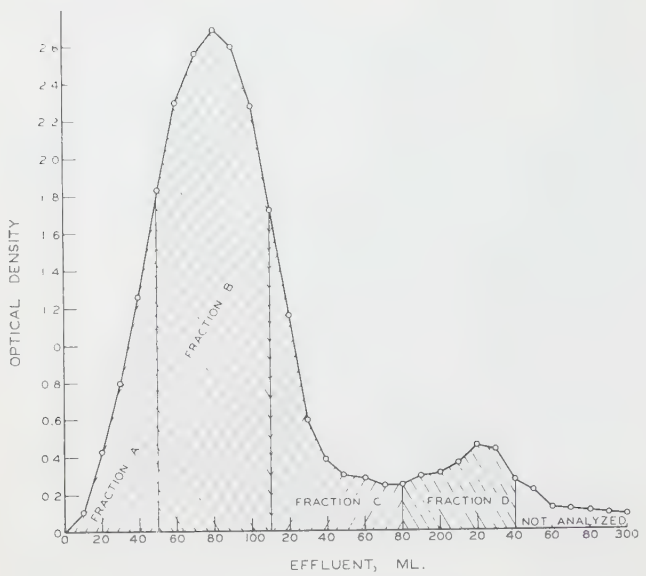


Fig. 1. Fractionation of lignosulfonates on a Dowex 50 W X2 ion-exclusion column

Summary of Analytical Data

	Weight % of recovered solids	*MeO, %*	*S, %*	*Relative mol. wt.*
Unfractionated material		5.75	10.92	5,050
Fraction A	12.25	12.18	5.22	8,030
Fraction B	41.37	11.04	6.74	7,770
Fraction C	26.75	2.43	14.85	1,710
Fraction D	19.63	3.12	11.87	1,000
Weighted av. fractions A–D	100.00	7.32	9.63	4,850

rest of the material, which contains the small interfering molecules, is discarded. Equal volume of 0.2*N* KCl is added to the first fraction, and finally it is made up to 100 ml. with 0.1*N* KCl and is used for diffusivity measurements. The extent of the fractionation achieved by ion exclusion has been established by model experiments using vanillin, furfural, and a number of indicator dyestuffs such as nitrophenol, methyl orange, brom cresol green, and congo red for additives. It was found that additives up to an absolute molecular weight of about 500 are completely excluded from the first fraction, and that the overlapping up to an absolute molecular weight of about 700 is not serious. In terms of relative molecular weight these values are about 1200 and 1800, respectively. It seems, therefore, that ion exclusion as outlined above successfully separates all low-molecular-weight interfering substances, and achieves also a separation of lignosulfates of the lowest molecular weight. This latter objective is not completely obtained, however, since overlapping is known to occur in the ranges given above. Complete separation of the small lignosulfonate molecules, up to a relative molecular weight of about 10,000, may be obtained by means of exhaustive dialysis through cellophane; this will be discussed under the corresponding section of this paper.

When more detailed analytical information on a lignosulfonate material is desired than just molecular weight on its ion-excluded fraction as obtained from Table I, Column A, Column B and a correspondingly larger sample of material is used. A total of about 5 g. of sample is collected in some 200 to 400 ml. of effluent from Column B, usually in 10-ml. portions. The collected effluents are first used to establish the distribution of the optical density in the effluent. Dilutions of 1 to 200 are prepared from each effluent sample, and the optical density is then read on a Beckman DU spectrophotometer at 281.5 mμ with a 0.3 slit. Figure 1 shows the results of optical density readings. The form of such curves, representing the optical density distribution in the effluent of the ion-excluded lignosulfonates, gives a great deal of information about the origin and possible treatments of the sample, and may be used for "fingerprinting" lignosulfonates. (This information is discussed in detail in Part II of this series.) The effluents are then grouped as marked on Fig. 1, and detailed analytical work is performed on each group. Suggested detailed analyses include determination of relative molecular weights and equivalent weights, and methoxyl, sulfur, and reducing sugars.

Experience from a great number of different lignosulfonate samples has shown that the low-molecular-weight organic substances which most seriously interfere are well separated by the ion-exclusion technique. Although the separation of the low molecular weight lignosulfonates is only partial, the interference in the portion used for diffusivity measurements is usually minor and does not greatly change the relative molecular weight figures. Complete removal of the lower molecular weight lignosulfonic acids up to relative molecular weight of about 10,000 can be obtained by means of exhaustive dialysis.

Fractionation by Means of Exhaustive Dialysis Through Cellophane

A number of fractionation methods including that of exhaustive dialysis through cellophane or other membranes has been in use for decades in lignin chemistry. Many usual methods of fractionation such as solvent extraction, fractional precipitation, or ion exclusion result in an overlapping fractionation. In these cases, it is possible to collect larger or smaller proportions of sample in the form of "high" or "low" molecular weight fraction, as may be desired, through variation of the experimental conditions.

Exhaustive dialysis through a membrane, as compared with most other methods, provides a sharper fractionation. Given sufficient time, all material able to diffuse through the pores of the membrane will diffuse through it. Thus, the extent of fractionation is determined by the pore size and by the uniformity of the membrane. Pore sizes for the different commercially available cellophane membranes range between 30 and 50 A.*

An attempt was therefore made to use exhaustive dialysis through cellophane as an alternative method for the separation of interfering low molecular weight substances from the lignosulfonic acids. In a batch-type operation a few grams of neutralized sample in aqueous solution is placed in a cellophane dialyzing tube (24/32 size, Nojax casing from the Visking Co., Chicago, Ill., unit weight 37.2 g.s.m.) of a suitable length to give about 150-ml. capacity. The ends of the tube are carefully sealed and the tube is immersed into 3 liters of distilled water. The distilled water is

* It is suspected that the amount and nature of sizing additive and wet-strength resin employed in the manufacture of the different cellophanes have a greater effect on the variations in their actual pore size than do the unit weights of the cellophane membranes.

replaced every day until it is indicated by color and by optical density readings that diffusion is no longer taking place. At this time, usually 4 to 8 days, the tubing is carefully opened. An aliquot of the undiffused material is used to establish the material balance after diffusion, and the rest of the material is used for diffusivity measurements.

Experimental data thus far indicate that the structure of the cellophane allows diffusion of the lignosulfonates up to a relative molecular weight value of about 10,000, corresponding to an absolute molecular weight of about 4000.

The percentage of lignosulfonates exceeding this limit, and thus not diffusing through cellophane, is extremely different in samples of different origin. At the end of a regular acid sulfite cook it may consist of only 15 to 25% of the lignosulfonates, while some fractions or lignosulfonate products may contain 80% or even more of such high-molecular-weight lignosulfonate material.

Experimental data from the application of these methods to specific problems will be presented and discussed in Part II of this paper.

SUMMARY AND CONCLUSIONS

Measurements of relative molecular weight of lignosulfonates by a diffusion method have resulted in a range of values from less than 1000 to about 100,000. Owing to more or less marked depression of the relative molecular weight values by the presence of low-molecular-weight substances which interfere with the optical density readings at 281.5 mμ, the necessity for eliminating such interfering substances prior to diffusivity measurements became evident. One practical way for fractionation was found in ion exclusion which results not only in good separation of interfering, small nonlignosulfonate molecules, but also in a simultaneous although overlapping fractionation of the lignosulfonates. Exhaustive dialysis through cellophane, as an alternative way of fractionation, results not only in a sharper fractionation than ion exclusion, but also in the removal of the low-molecular-weight lignosulfonates from the sample. Detailed experimental outlines for molecular weight determinations by means of diffusivity measurements and for the two suggested fractionation procedures are presented along with results obtained by these methods separately and in combination.

The method as described has proved to be well suited to the average laboratory working in the field of wood chemistry; a nominal amount of extra equipment is required and about six determinations can be made daily by an analyst.

LITERATURE CITED

1. Jander, G. and Spandau, H., *Zeitschrift fur Physicalische Chemie* 185: 325 (1939).
2. Schwabe, K. and Hasner, L., *Cellulosechemie* 20: 61 (1942).
3. Pennington, D. and Ritter, D. M., *J. Am. Chem. Soc.* 69: 667 (1947).
4. Weissberger, A., "Physical Methods of Organic Chemistry," 2nd ed., Vol. I, Part I, Chapter XII, New York, Interscience Publishers, Inc., 1949.
5. Gordon, A. R., *Ann. N. Y. Acad. Sci.* 46: 285 (1945).
6. Wheaton, R. H. and Bauman, W. C., *Ind. Eng. Chem.* 45: 228–233 (Feb., 1953).
7. "Dowex: Ion Exchange," the Dow Chemical Co., Midland, Mich., 1958.
8. Felicetta, V. F., Lung, Michael, and McCarthy, J. L., *Tappi* 42, No. 6: 496 (June, 1959).
9. Perry, John H., "Chemical Engineers' Handbook," 3rd ed., Section 11, page 754, New York, McGraw-Hill, 1950.

Received June 22, 1961. Revision of paper read before the Section of Physical Chemistry, American Chemical Society, New York, N. Y., September, 1960.

Measurement of the Relative Molecular Weight of Lignosulfonates by Diffusion

II. Determination of Relative Molecular Weights on Various Lignosulfonates

JULIUS BENKO

Relative molecular weight information as obtained by a previously described diffusivity method is presented on a variety of lignosulfonate materials which have been treated in various ways. During the progress of different pulping processes in the acid or neutral pH range, lignosulfonates of relative molecular weight of 1,000 to 10,000 were obtained. Results indicate that an increase in molecular weight occurs during the cook and the increases obtained appear characteristic for any given set of cooking conditions. Fractionation of spent sulfite liquor by solvent extractions results in a range of values between 1,200 and 10,300. Gross interference in the method by small amounts of low-molecular-weight impurities is shown, and the effectiveness of ion-exclusion technique for fractionation is discussed. Through variation of spray-drying conditions, the relative molecular weight of lignosulfonates may be maintained practically unchanged, or, alternatively, up to 80% increase may be obtained. Simultaneously, the percentage of the total material consisting of such larger molecules is increased by up to 100%. Relative molecular weight data on six commercially available lignosulfonate samples show the following ranges: (a) without fractionation 2,400 to 10,700; (b) following ion-exclusion 6,000 to 19,800; (c) following dialysis through cellophane 14,000 to 36,300. Values in excess of 15,000 indicate that such materials were subjected to treatments resulting in the increase of their molecular weight following the cooking process. The distribution pattern of the optical density of lignosulfonates in the effluents of ion-exclusion columns is shown to be characteristic for lignosulfonates of different origin and treatment. Usefulness of such optical density distribution curves for "fingerprinting" of lignosulfonate samples is indicated.

Julius Benko, Lignin Chemist, Sulphite Pulp Manufacturers' Research League, Appleton, Wis.

In Part I, preceding paper, a method was described for determination of the relative molecular weight of heterogeneous polymeric mixtures of lignosulfonic acid compounds such as are found in spent sulfite liquor. Part II describes the application of this method and the interpretation of the data to practical problems. Several pure organic substances of known absolute molecular weight are used as a basis of comparison between relative molecular weight determinations of mixtures and the absolute values for molecular weights. In order to present the data in a paper of reasonable length, detailed methods of preparation of the test mixtures are not given in all cases and the analytical data have been summarized.

From the data presented, it will be observed that by this diffusion method for relative molecular weight determination a range of from 1000 to about 100,000 derives from an absolute molecular weight range between 350 and 40,000. The scale-up factor of about 2.5 is disadvantageous, of course, in making necessary the use of an indirect and not too exact interpretation of results, but it is believed that the advantages of having reproducible and practical methods for obtaining the relative values greatly aids in obtaining comparative information which can be used at this time without waiting for the development of methods for the determination of absolute molecular weight values.

EXPERIMENTAL

Investigation of the Sulfite Cooking Process—Example I

Samples taken at regular intervals from a commercial digester during a calcium base acid sulfite cook on softwood have indicated the continuous increase of the relative molecular weight values of lignosulfonates during the cook. Table I gives the experimental data measured on the unfractionated spent liquors.

Table I clearly indicates that there is a continuous increase of the molecular weight as well as of the tannin purity. Tannin purity is measured as the weight percentage of the material which is chemically bound to the hide, when analyzed according to the method of the American Leather Chemists' Association (*1*).

Samples 2, 4, and 6 were further investigated by the combination of ion exclusion and relative molecular weight measurements. Figure 1 shows a characteristic shifting of the optical density distribution curves in the effluents with cooking time. From the comparison of a number of similar fractionation curves it has been established that narrow first waves with a high peak indicate high-molecular-weight lignosulfonates, while wide first waves with low peaks and a fairly large second wave indicate low-molecular-weight material. This can readily be seen in the present case as well as in data to be presented later in this paper.

Following the fractionation by means of ion exclusion, four groups were made from each effluent, and relative molecular weight values were established, as shown in Table II.

The data in Table II show that ion exclusion has accomplished a fractionation of the sample material in each case. Methoxyl analysis indicates that the bulk of the lignosulfonate material is included in the first and second groups, while the third and fourth groups contain only about 10% of the methoxyl present in the original sample.

Comparison of data presented in Tables I and II demonstrates that the relative molecular weight values of the unfractionated samples are depressed by the presence of the smaller molecular weight fractions. The extent of the interference which may be caused by a small percentage of low-molecular-weight fraction in the total quantity of sample material varied greatly, according to the origin and previous treatments of the sample. For this reason, ion exclusion and diffusion through cellophane have been adapted as purification steps for the removal of the interfering low-molecular-weight substances. For routine diffusivity measurements the first and second effluent groups from Table II are collected together and used, while the low molecular weight fractions in the third and fourth group are discarded.

Relative molecular weights have been established on a number of different spent sulfite liquors. Measurements were performed usually on a sample material

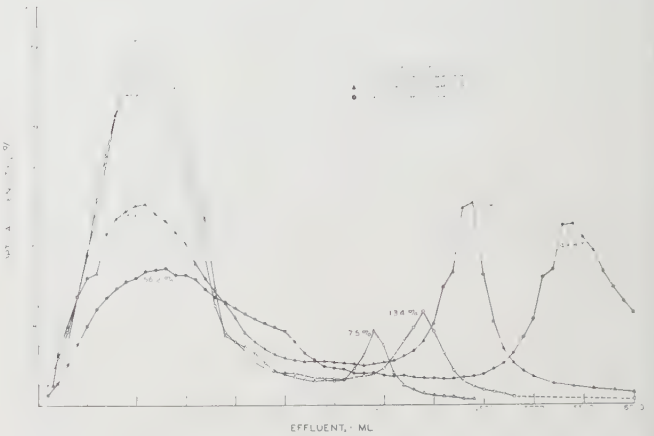


Fig. 1. Investigation of the sulfite cooking process

Fractionation by means of ion-exclusion on the Dowex 50*W* X2 column

purified by ion exclusion, since such samples represent the largest part of the original material freed from grossly interfering substances in the analytical procedure.

Diffusivity measurements for relative molecular weight determination, preceded by ion exclusion, have been employed to help in studying and evaluating the nature of the lignosulfonic acid compounds in a wide variety of spent sulfite liquors. The study has included spent liquors from acid sulfite cooking with calcium, ammonium, magnesium, and sodium pulping bases, from fast and slow cooks, and from softwood and mixtures of softwood and hardwood. Spent liquors from modified, or less acid, and high-yield pulping processes, such as magnefite and arbiso cooks, and from various modifications of the neutral sulfite semichemical process have also been evaluated. Relative molecular weights following ion exclusion were found to be characteristic and reasonably constant in the range of 3500 and 10,000 for any given set of cooking conditions. Increasing pH during the cook and decreasing time of cooking both seem to produce lignosulfonates of lower molecular weights. Lignosulfonates of highest relative molecular weight were obtained from longer cooking time and from the more acid sulfite cooks.

Table I. Increase in Relative Molecular Weight and Tannin Purity During Pulping Process

Calcium base acid sulfite cook of sprucewood

Sample no.		*Relative mol. wt.*	*Tannin purity A.L.C.A. method*
1	Taken 9.5 hr. prior to end of cooking	1470	9.15
2	Taken 7.5 hr. prior to end of cooking	1840	12.40
3	Taken 5.5 hr. prior to end of cooking	2520	14.80
4	Taken 3.5 hr. prior to end of cooking	4260	26.15
5	Taken 1.5 hr. prior to end of cooking	4930	30.40
6	Taken at end of cook	5500	33.30

A number of the liquors were also subjected to exhaustive dialysis through cellophane, and relative molecular weights were measured on the undiffused, high-molecular-weight fractions. Relative molecular weight values for fractions so obtained were found to be in the order of 10,000 to 15,000. In each case the portion which did not diffuse through cellophane accounted for about 10 to 30% (by weight) of the original spent sulfite liquor solids. The correlation of the results as measured following dialysis through cellophane and following ion exclusion is shown to be good. High relative molecular weight values following ion exclusion indicate higher percentages of solids unable to diffuse through cellophane and higher relative molecular weight values in the undiffused material.

Figure 2 presents data for optical density distribution obtained following the fractionation of a neutral sulfite semichemical liquor by means of ion exclusion.

The distribution pattern of the optical density of the two effluents of fractionated, but otherwise untreated, neutral sulfite liquors shown in Fig. 2 is basically different from the pattern of the acid sulfite liquors shown in Fig. 1. However, following the transfer of the organic components of the neutral sulfite liquor into an acid cooking liquor and after an additional heat treatment, the usual fractionation curve for acid spent sulfite liquors is also obtained in Fig. 2. Relative molecular weight values for the unfractionated lignosulfonates from the neutral sulfite cook were found to be unrealistically low. Values between 1000 and 1400 were measured and after ion exclusion, a relative molecular weight value of 3500 was obtained. In the case of the unfractionated samples there was evidence of a gross interference by some low-molecular-weight components of the liquor. As a final step in the evaluation of the neutral sulfite semichemical spent liquor a portion was subjected to exhaustive dialysis and the small amount of residual material which did not dialyze was found to have a relative molecular weight of 13,100. This fraction accounted for only 8% of the total untreated liquor solids.

Figure 3 presents data obtained following the fractionation of the spent liquor from a fast, ammonia base, mixed hard- and softwood cook. One sample was analyzed in the form in which it was obtained at the end

Table II. Relative Molecular Weight Classification Achieved by Fractionation from Ion-Exclusion Column

Sample (from Table I)	*Sample 2*	*Sample 4*	*Sample 6*
First effluent group	3600	5800	5740
Second effluent group	2640	7250	7110
Third effluent group	1090	1710	1700
Fourth effluent group	880	1260	1040

Fig. 2. Fractionation of lignosulfonates from the neutral sulfite process by means of ion exclusion

of the cook, and a second sample was analyzed following an additional heat treatment of the same spent liquor in an autoclave at 140°C. for 6 hr. As Fig. 3 clearly shows, the additional heat treatment has resulted in a fractionation curve similar to that obtained at the end of a slow, calcium base cook of softwood liquor. The polymerization of lignosulfonic acids during the additional heat treatment has been indicated by relative molecular weight data, showing a value of 1550 at the end of the cook, and of 3650 after the additional heat treatment. Diffusivity measurements were performed on the unfractionated spent liquors, since at that time our fractionation procedures had not yet been developed, and therefore the results are probably depressed by the presence of the low-molecular-weight components of these liquors.

The reducing sugar content of the spent liquor decreased by about 50% during the additional heat treatment, and our observation leads us to suggest that sugar degradation products probably have an important function in the polymerization or condensation of lignosulfonic acids under the given conditions.

Relative Molecular Weight Data for Spent Sulfite Liquor Fractions Obtained by Extraction with Organic Solvents—Example II

A. Relative molecular weight data of lignosulfonate fractions from a multistage, acetone-water extraction of spent sulfite liquor solids in acid medium were obtained as shown in Table III. These results confirm earlier findings that the lignosulfonate fractions may

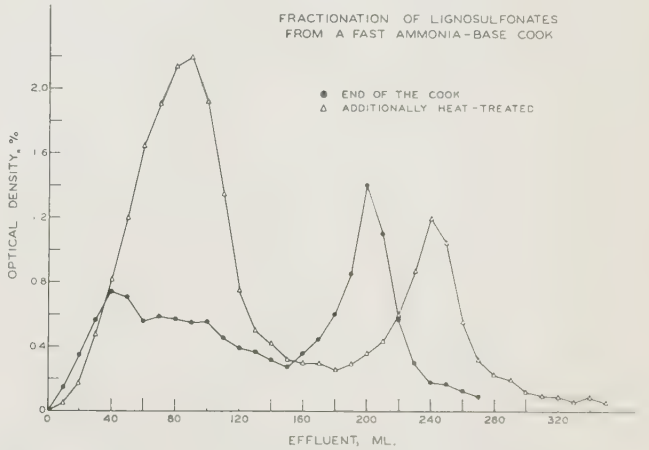


Fig. 3. Fractionation of lignosulfonates from a fast ammonia-base cook

Table III. Relative Molecular Weights of Solvent-Extracted Lignosulfonate Fractions

		Relative mol. wt.
Fraction A	Soluble in 100% acetone at pH close to 0.0	1,230
Fraction B	Soluble in 80% acetone 20% water mixture while strongly acid. Final product remains soluble after neutralization with NH_4OH	2,360
Fraction C	Soluble in the above mixture while acid, but precipitating after neutralization with ammonia	3,680
Fraction D	Soluble in water, following stepwise removal of fractions A, B, and C	10,330

be effectively fractionated by suitably selected steps of solvent extraction and with concurrent control of the degree of acidity and water solubility relationships.

B. Spent sulfite liquor of a relative molecular weight of 4090 (measured on the unfractionated material) was fractionated by means of isopropyl alcohol extraction into organic and aqueous soluble fractions. By varying extraction conditions, different percentages of solids have been obtained in the organic and aqueous layers, respectively. The percentage distribution of solids was established, the relative molecular weights were measured, and the values for the unfractionated spent sulfite liquor were recalculated. Results are shown in Table IV.

A number of mixtures have been prepared from the fractions described in Table IV, and the depressing effect of the lower molecular weight components of the mixture upon the relative molecular weight values of these mixtures was studied. The experimental values as the percentage of the calculated relative molecular weights were generally within the limits given in Table IV. However, after mixing the high-molecular-weight fractions A and C, the lowest experimental value as the percentage of the calculated relative molecular weight was 92.9%. These data demonstrate that the most serious interference in relative molecular weight measurements originates from the very low-molecular-weight impurities of a mixture.

The Effect of Low-Molecular-Weight Additives Upon Relative Molecular Weight Values—Example III

To establish the effect of low-molecular-weight impurities, of known composition, upon the relative molecular weight values of lignosulfonates, and thus the extent of interference which might be due to the presence of such small molecules, the effect of the addition of small amounts of furfural and vanillin was studied. The experimental data are summarized in Table V.

The data in Table V demonstrate that the depressing

Table IV. Data on Lignosulfonate Fractions Extracted with Isopropyl Alcohol (IPA)

Extraction	Percentage wt. distribution of solids — Solubles — IPA	Solubles — Aqueous	Relative mol. wt. of LSA[a] — Solubles — IPA	Solubles — Aqueous	Calculated relative mol. wt., orig. SSL[b]	Experimental value, as percentage of calculated rel. mol. wt.
A	9.7	90.3	1175	5200	4809	85.0
B	28.3	71.7	1810	6690	5297	77.2
C	43.8	56.2	2750	8750	6120	66.8

[a] Lignosulfonic acid.
[b] Spent sulfite liquor.

Table V. Effect of Low-Molecular-Weight Additives on the Relative Molecular Weights of Lignosulfonates

Expt. no.	Lignosulfonate component	Additive — Compound	Additive — Wt., %	Additive — Optical density, %	Relative mol. wt. — Experimental	Relative mol. wt. — Calculated	Relative mol. wt. — Experimental as % of calcd.
10	Mixture of extn. B, organic and aq. solubles[a]	Furfural	2.45	54.6	810	5190	15.6
11	Extn. B, aq. soluble[a]	Furfural	1.66	37.2	2405	6584	36.5
12	As above	Vanillin	0.57	1.1	4850	6621	73.3
13	As above	Vanillin	1.14	2.2	4185	6553	63.9
14	As above	Vanillin	2.28	4.4	3085	6422	48.1

[a] From Table IV.

effect of a small amount of furfural or vanillin is many times higher than that of similar amounts of low molecular weight lignosulfonates.

Investigation of the Effectiveness of Ion-Exclusion Procedure for the Separation of Low-Molecular-Weight Impurities from Lignosulfonates—Example IV

Data similar to that presented in the previous examples have repeatedly shown that the most serious interference with diffusivity measurements originates from the lowest molecular weight impurities of the sample. The data have also indicated that fractionation by means of ion exclusion greatly reduces or completely eliminates such interferences.

In order to gain some quantitative idea about the extent of fractionation by means of ion exclusion, as described in the first part of this paper, a few model experiments were performed. First, sodium salts of the indicators congo red, bromothymol blue, and methyl orange were ion excluded in a mixture, and were collected distinctly separated in the effluents. The indicators appeared in the effluent in the above order, which is the order of their decreasing molecular weights. This experiment illustrates that during ion exclusion not only the ionic and nonionic nature of the components but their molecular weight or size is also an important factor. Next, an ammonia base spent sulfite liquor was fractionated by means of ion exclusion without additives, and then after the addition of furfural, *o*-nitrophenol, methyl orange, phenol red, and bromothymol blue. Examination of the effluents from the ion-exclusion column showed the first four additives to have been completely separated from the high-molecular-weight lignosulfonate fraction, and that overlapping of the bromothymol blue into the high-molecular-weight lignosulfonate fraction in the effluents was slight. Thus it appears that additives up to molecular weight of 500 to 600 are completely sepa-

Table VI. Relative Molecular Weights of Pure Organic Substances

Expt. no.	Material	Relative mol. wt. based on KCl factor	Mol. wt.	F = Relative Mol. Wt. / Mol. Wt.
1	Methyl orange Na	834	327	2.55
2	*m*-Nitrophenol Na	368	161	2.29
3	Vanillic acid Na	570	190	3.00
4	Vanillin	372	152	2.45
5	Raffinose	1253	504	2.49
6	Lactose	967	342	2.83
7	Xylose	437	150	2.91

Table VII. Relative Molecular Weights of Spray-Dried Lignosulfonates

Material	Relative mol. wt. Ion-excluded	Relative mol. wt. Cellophane-dialyzed	Wt. percentage in the sample undiffused through cellophane in 5 days
SSL, prior to spray-drying	6280	9,300	26.8
SSL, spray-dried under conditions X*	4310	9,760	31.8
As above, Y*	5500	16,300	46.7
As above, Z*	9000	16,500	53.7

* Spray-drier conditions X, Y & Z involve increasing exposure to heat treatment.

rated, and serious overlapping first occurs in the case of molecules having molecular weights higher than 800 with the bulk of such an additive still being separated. The above data therefore indicate that ion exclusion provides a good separation of the low-molecular-weight impurities from the lignosulfonates, but it is not likely to provide sharp separation of the different, larger lignosulfonate molecules.

Diffusivity Measurements of Pure Organic Substances—Example V

Diffusivity measurements on a few pure organic substances have been performed and the corresponding relative molecular weight values have been calculated. Unfortunately only substances of relatively low molecular weights are readily available. Thus, owing to the lack of high-molecular-weight reference substances, results for most lignosulfonate samples have to be extrapolated, regardless of which of the available substances of known molecular weight is chosen for the basis of comparison in our measurements.

The reproducibility of diffusivity measurements is well known and well accepted even in the highest known range of molecular weight values but, on the other hand, it has been questioned as long as 20 years ago by Schwabe, *et al.* (*2*), whether or not extrapolation can be properly practiced to the degree we find necessary in this method for determination of the relative molecular weight of soluble lignin compounds. For lack of better alternatives, we have to continue this practice of comparing very large molecules with very simple and small ones. It should be emphasized, however, that this inherent source of possible error is definitely recognized. Relative molecular weight values of a few pure organic substances are given in Table VI.

The data in Table VI indicate that the use of the KCl constant results in relative molecular weights which are, on the average, 2.65 times higher than the absolute values.

Investigation of the Spray Drying Process—Example VI

Although the unit operation which we call spray-drying implies nothing else but removal of water and thus producing a dry powder, those familiar with the spray-drying of spent sulfite liquor know that the removal of water is not the only possible change caused by this operation. Through the variation of drying conditions it is possible, for instance, to more than double the tannin purity of a spent liquor. It is also possible to improve significantly the dispersing properties of the spent sulfite liquor solids by properly chosen spray-drying conditions. Such changes usually cannot be explained by data from chemical analyses, since the percentages of methoxyl and sulfur contents do not indicate significant changes. Relative molecular weight data, however, indicate very significant changes with variation of drying conditions, and the improvements indicated by the application tests can be closely related to the changes of the macromolecular structure of the material.

Table VII presents relative molecular weight data on an ammonia base spent sulfite liquor and on spray-dried products obtained from this liquor under different drying conditions.

A stepwise increase in the extent of polymerization of the lignosulfonates is shown in Table VII. Studies to be reviewed in subsequent papers in this series show that this information is of considerable value in predicting and evaluating the surface active and other marketable properties of these materials.

Table VIII. Relative Molecular Weights of Commercial Lignosulfonates

Material	Relative mol. wt. Unfractionated	Relative mol. wt. Ion-excluded	Relative mol. wt. Dialyzed	Wt. % in dialyzed sample
Product A	5,300	9,300	23,600	53
Product B	3,020	6,820	18,900	24
Product C	6,880	12,200	20,800	43
Product D	10,700	19,800	36,300	60
Product E	4,000	5,950	14,500	23
Product F	2,390	7,680	14,000	15

Relative Molecular Weight Data of Commercial Lignosulfonate Products—Example VII

As a further example, relative molecular weight data have been determined without fractionation, after ion exclusion and after exhaustive dialysis through cellophane, on different commercially available lignosulfonates, and are presented in Table VIII.

Table VIII indicates that products E and F were not treated to increase their molecular size significantly above that already obtained in the digester, while the other four products were subjected to such a treatment to different extents.

SUMMARY

Data based upon a diffusivity method for determining the relative molecular weight of soluble lignosulfonate compounds are presented which show that useful information is obtained about the macromolecular structure and the distribution of different types or sizes of lignin compounds in a great variety of materials derived from pulp mill spent sulfite liquors. Further studies are under way which are to be presented in a subsequent paper in this series. The examples presented show that for effective interpretation of the results of relative molecular weight determinations, it is usually necessary and desirable to perform fractionation steps utilizing the principles of ion exclusion or of exhaustive dialysis through cellophane.

LITERATURE CITED

1. American Leather Chemists Assoc., Methods of Analysis & Sampling (1957) Method A22, Non-Tannins and Tannins.
2. Schwabe, K., and Hasner, L., *Cellulosechemie* 20: 61 (1942).

Received June 22, 1961. Revision of paper read before Section of Physical Chemistry, American Chemical Society, New York, N. Y., September, 1960.

The author wishes to express his thanks to Mrs. Magdalene Benko, analytical chemist, and to Dewey W. Grothe, technician, for their valuable help in performing most of the routine work presented in this paper.

Fiber Dimensions of Nonwoody Plant Materials

R. E. PERDUE, JR., and H. J. NIESCHLAG

Data on fiber dimensions were compiled from the literature to provide a partial basis for a general evaluation of nonwoody plant materials as sources of paper pulp. These data are interpreted in terms of the fiber characteristics of aggregates of individual species as representative of large natural or artificial plant groups. The fiber characteristics of selected groups of nonwoody materials are compared with the fibers of the woods of broadleaved and coniferous trees. Study of dimensional characteristics indicates that, among the monocotyledons, the grasses offer the greatest potential as suitable raw materials. Similarly, among the dicotyledons, the most valuable raw materials will be those plants which contain large quantities of bast fibers.

American industry today utilizes more cellulose than any other plant product. In 1956, industry consumed a little over 33 million tons of wood pulp, straw, and other raw materials to produce almost 31.5 million tons of paper and board (*1*). In 1956 the United States produced 29.1 million cords of softwood pulpwood and 6.1 million cords of hardwood pulpwood (*2*). The U. S. Forest Service estimated that the 1975 demand for pulpwood may be 45 to 65% higher than in 1956 (*2*).

While it is not our purpose here to inquire into the ability of American forests to continue to satisfy the increasing demand for pulpwood, it is evident that the vast cellulose market in this country offers an opportunity and a challenge to American "nonforest" agriculture. If American agriculture can economically produce a nonwoody plant source of fibrous cellulose, a means will be at hand for the partial solution of one critical problem of the present, and possibly of an even more critical problem of the future. The successful development of a new crop as a source of industrial cellulose will serve to replace crops now in surplus and contribute to the stability of our agricultural economy. A new source of cellulose will also ensure a continued adequate supply of raw material for industry.

The suitability of a fibrous raw material for manufacture of paper is dependent on several factors, one of the more important of which is the dimensions of the ultimate fibers. Fiber-dimension data were compiled from the literature to provide a partial basis for a general evaluation of nonwoody plants and bamboos as potential sources of paper pulp. While dimensions of fibers from individual species are of great interest, the primary purpose of this work is to examine these data in terms of the fiber characteristics of aggregates of individuals of large natural plant groups, to recognize general systematic trends in fiber properties rather than specific details, and particularly, to answer as well as possible, the question: do certain families or other groups of plants stand out as potential sources of paper pulp?

The plant kingdom is far too large to examine each possible source. Such a survey as that presented here should help point the way to groups of plants which are most likely to include members that will serve as desirable sources of paper pulp. Information included in this paper provides a basis for further study of paper raw materials.

HISTORICAL

Since the origin of papermaking, about A.D. 105, papermakers have used various raw materials and have given their attention to the possible utilization of many plants. The first paper mill in the United States, established in 1690, used linen rags. Until about 1800 all commercial pulps were made from either cotton seed fiber or bast fibers of various plants. Straw pulp was first produced in this country on a successful commercial basis in 1831, and, owing to the limited supplies of rags available, attained a status as the most important paper raw material. Commercial production of pulp from wood began in 1854. Since this time the use of most categories of fibrous raw materials has increased, but the increase in amount of wood pulp has been far above that of all other raw materials. The 600,000 short tons of fibrous raw materials consumed in the United States in 1879 consisted of 3.5% wood pulp, 38.3% straw, 31.1% rags, 13.7% wastepaper, 13.2% Manila rope, and 0.2% other materials. By 1956 the paper industry consumed over 33 million tons of raw material consisting of 69.3% wood pulp, 26.8% wastepaper, 0.6% straw, 1.0% rags, and 2.3% other materials (*1*).

CURRENT USE OF NONWOODY MATERIALS

For many years wood has been the favored raw material for the manufacture of paper, but nonwoody fibers have found an important though small place. They come into use most commonly in areas of the world where wood is in short supply, or for special purposes for which they are better adapted than wood. Grain straws are an important source of paper in areas short of wood. Sugarcane bagasse is becoming increasingly used as a papermaking material. In India, papermakers have used large quantities of sabai grass [*Eulaliopsis binata* (Retz.) C. E. Hubbard] and have now turned to bamboo as the primary indigenous pulp material. Bamboo is also used for paper in Japan, China, and in several tropical and subtropical areas. A cane (*Arundo donax* L.) was used in Italy prior to World War II for the manufacture of rayon pulp. Straws and bagasse are used as substitute raw materials in the United States.

For certain specialty papers, specific nonwoody fibers are unsurpassed in quality. Esparto grass

R. E. Perdue, Jr., Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md. H. J. Nieschlag, Northern Regional Research Laboratory, Peoria, Ill. This is a laboratory of the Northern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

(*Stipa tenacissima* L.) is used in England for the manufacture of fine-quality printing papers. Flax straw (*Linum usitatissimum* L.) is used in the United States for manufacture of cigarette tissue and is used elsewhere for bank-note and other fine papers. Old Manila rope and certain grades of new Manila fiber (*Musa textilis* Nee) are used for the production of strong thin papers that cannot be produced from even the best coniferous pulps.

In spite of the fairly common use of nonwoody plants for the manufacture of paper, almost without exception there has been no successful cultivation of a plant to be used primarily as a papermaking raw material. The nonwoody raw materials mentioned above and other examples that might be cited are, with few exceptions, collected from existing wild stands or are obtained as residues from agricultural crops produced primarily for another end use. One exception, the cultivation of *Arundo donax* in Italy for the production of rayon pulp was not a profitable venture. The most extensive production of papermaking plants as agricultural crops is probably in Japan where mitsumata (*Edgeworthia papyrifera* Sieb. & Zucc.) and kozo or paper mulberry (*Broussonetia kazinoki* Siebold, *B. papyrifera* Vent.) are widely grown. Although both of these fibers are fine-quality raw materials for papermaking, their production as a cultivated crop is dependent upon a large supply of low-cost labor and their utilization for the manufacture of special, high-value papers.

COMPILATION AND INTERPRETATION OF FIBER-DIMENSION DATA

Relation of Fiber Dimensions to Paper Quality

Other factors being equal, paper strength is related to fiber length, and to the fiber length-diameter ratio. High length-diameter ratios increase the number of fiber-to-fiber contacts or bonds, and favor high tear and folding strength (*3*). Long narrow fibers also contribute to tensile strength, bursting strength, and other strength factors (*4*, *5*). Pulps containing long narrow fibers are better adapted for the incorporation of strength into a thin paper than are pulps with long but relatively broader fibers. These strong thin papers are especially desirable for certain uses such as condenser paper, cigarette paper and tea-bag paper.

High length-diameter ratios lose significance in fibers with average lengths much greater than 3 mm. These long fibers tend to clump or tangle and cannot be satisfactorily formed into a sheet of uniform texture (*6*). However, fibers which are of sufficiently small diameter that fragments 2 to 3 mm. long have high length-diameter ratios are desirable raw materials for good-quality papers.

Fiber dimensions also affect paper texture. Fibers with small diameter can be used to prepare papers with smooth texture, that are less porous, and present a better printing surface than papers made from fibers of larger diameter.

Examples of modern usage of these desirable long narrow fibers are the use of the bast fiber of seed-flax straw to afford high resistance to scuff and tear in currency papers, and the use of abaca to give high strength in thin paper used for tea bags.

While fiber dimensions are a very important factor, the overall strength of a sheet of paper is dependent on the interrelationship of other fiber characteristics the thickness of the cell wall, the chemical nature of the fiber, the degree to which the cellulose structure is degraded during pulping, the ability of the fiber to develop bonding capacity during the papermaking process, and so forth.

Numerous plant species are technically suitable for papermaking because the physical and chemical properties of their fibers are of satisfactory quality. Any new raw material, however, must be able to compete with existing raw materials. It must contain a large amount of useful fiber of acceptable quality; it must be easy to pulp and must produce a pulp that is easy to bleach. It must be of such a nature that it can be economically produced, harvested, and delivered to a suitable mill site in a quantity great enough and reliable enough to assure an adequate and continuous supply to the mill. No new fibrous raw material has been able to compete successfully with wood on a large scale in the United States, since the pulping of wood gained headway during the latter half of the 19th century. It should be noted, however, that the decline in the utilization of grain straw, from a peak of some 666,000 tons in 1941 to 213,000 tons used in 1956 (*1*), was due to problems of straw procurement rather than to any technological deficiency of this material.

Sources of Fiber-Dimension Data

The data upon which this report is based were all taken from the literature.* The oldest reference used was Wiesner's *Die Rohstoffe des Pflanzenreiches* published in 1873. Part of the data was from earlier works but was taken from secondary references. As far as possible, original sources were consulted but secondary references were used when original sources could not be located.

The term "fiber," as used in this paper, bears the connotation, as generally understood in paper-industry terminology, of a relatively long and narrow, single-celled structural element of a plant. This connotation includes the cellular elements known to the botanist as true fibers, tracheids, and possibly also vessels and sieve tubes.

Fiber-dimension data in the literature, on the whole, originated as a result of two separate objectives. A majority of the analyses were made as a part of complete characterizations of spinning fibers that were at the time in use or considered as possible new products. Many were samples of fiber used by the native population of European colonial possessions, for which it was hoped that a market in Europe or elsewhere could be found. Many samples were from plants, related to species then in accepted use, that seemed to offer potential as new sources. Interest in new fiber sources from colonial possessions is responsible for a preponderance of analytical data about plants of tropical origin.

A small number of the analyses were originally made in the interest of examining the potential use of these materials as sources of paper. Fibers indigenous to colonial possessions which were recognized as being unsuitable for use as rope, bag, or other spinning

* This compilation of data is too lengthy to be included here. A copy may be obtained by addressing a request to: New Crops Research Branch, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

fibers were thought to be of possible use for papermaking. Grasses and other plants that were of great abundance in colonial possessions were considered to be possible sources of raw material. Wartime conditions, creating a shortage of pulp through reduction in imports or by increased consumption of cellulose products, stimulated research on new papermaking raw materials in several countries. In relatively recent years the interest in research on papermaking raw materials has been greatly stimulated by the shortage or scarcity of pulpwood in several areas of the world.

The general pattern of research on nonwoody plants as potential sources of fibrous raw materials has involved comprehensive studies of a relatively small number of plants. Hence, we know a relatively great deal about a small number of plant species from the standpoint of their value as papermaking raw materials, and the number of species for which fiber dimensions have been reported is not as great as might be expected.

An exception to this general rule is the current research program on potential papermaking raw materials conducted by the U. S. Department of Agriculture (*7*). This program is presently concerned with "screening" a broad representation of higher plants and involves study of only the most basic physical and chemical properties. Data originating from this research are not included in the present compilation. This U.S.D.A. program is the first instance in which a large number of plant species have been examined as possible papermaking raw materials, using uniform methods. The data derived from this current program provide a basis for reliable comparisons of potential raw materials and deserve independent study.

Basis of Compilation of Data on Fiber Dimensions

The compilation used as a basis of this paper, with certain exceptions, includes all available data on the dimensions of the ultimate fibers of nonwoody plant materials. Species for which only measurements of fiber diameter are available were excluded; however, those species were included for which fiber length alone was given. The compilation does not include data for seed fiber such as *Gossypium* (cotton) or *Asclepias* (milkweed) or for woody plants except for those referring to the bast fibers of such species. Data on bast fibers of woody plants were included primarily to provide additional information for families which are poorly represented by data on the bast of nonwoody species. While bamboos are "woody" in the sense of the hardness of their tissues, they are structurally like the more typical grasses, as are such other "woody" grasses like *Arundo donax* and *Phragmites communis* Trin.

Problems in Interpreting the Data

In interpreting these data it must be kept in mind that this information has many origins. The data used to prepare the diagrams represent the work of numerous investigators, very few of whom followed the same methods of analysis. There is great variation in reported fiber dimensions of certain species. This is probably due more to variation in methods of analysis than to variation in the plants studied. Some analyses were based on carefully made macerates of fibrous material in which very few of the fibers were broken; others were based on crude pulps in which many fibers were broken. It is evident that sampling methods were not uniform. Another, and probably the most important, source of variation in reported average fiber lengths of individual species was the arbitrarily selected minimum fiber length included in measurements and calculations. Elements only 0.1 mm. long were included in some calculations whereas the minimum length included in others varied from 0.2 to 0.5 mm.

Even in the case of wood, which is a relatively homogenous material, there has been considerable controversy as to just how average fiber length should be determined. The problem of obtaining reliable and comparable data from nonwoody materials is much greater due to the lack of homogeneity in these materials.

Explanation of the Scatter Diagrams

Selected data from the compilation are incorporated in the accompanying scatter diagrams. The groups represented in these diagrams are limited to those natural or artificial assemblages for which sufficient data are available. The diagrams provide an opportunity to evaluate significant trends in larger groups, based on data from member species. The plants can be considered as representatives of larger groups rather than as individuals. Inconsistencies due to variation in analytical methods are minimized. The data in most of these diagrams are by no means sufficient to afford an adequate sample of the group in question; but the diagrams provide the most satisfactory basis for evaluating the information that is now available, and they provide simplified graphic illustrations with which new data can be compared. The diagrams illustrate vividly the most important dimensional factors: average fiber length, average fiber diameter, and length-diameter ratio.

As illustrated by the explanatory diagram (Fig. 1), average fiber length is plotted along the vertical axis, and average fiber diameter is plotted along the horizontal axis. The oblique lines are arranged to indicate length-diameter ratios. For many species the literature provides data on average fiber length but no information on average fiber diameter. These species are represented by entries just outside and to the right of the appropriate diagrams. In the Malvaceae (Fig. 9) and in certain of the families represented in Fig. 10, the average bast-fiber length of a few species is too great to be plotted on diagrams of the scale employed here. These species are represented by entries just outside and above these diagrams.

American Coniferous and Broadleaved Trees as a Basis of Comparison

Data on American coniferous (softwood) and broadleaved (hardwood) trees (*8*, *9*), are included to provide a basis of comparison between nonwoody plant materials and woody materials currently in use in the United States. Softwood fibers (Fig. 2) are long (2–5 mm.) and relatively broad. Length-diameter ratios vary from 75 to 125, but for a majority of the species they are less than 100. The four most important species of southern yellow pine, *Pinus taeda* L., *P. echinata* Mill., *P. palustris* Mill., and *P. elliottii* Engelm. ex Vasey (*P. caribaea* Morelet) are shown separately on the diagram. These are the principal softwood species of the southeastern United States, an area to which several interesting spe-

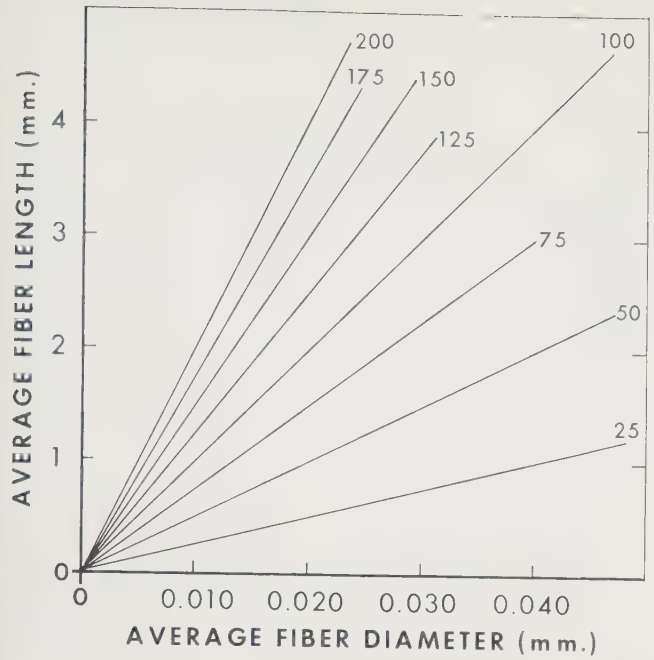


Fig. 1. Explanatory diagram for Figs. 2–12. The oblique lines are arranged to indicate length-diameter ratios. Those plants for which only average fiber lengths are available are represented by entries just outside and to the right of the diagrams. Those plants with average fiber lengths too great to be plotted on diagrams of the scale used here are represented by entries just outside and above the appropriate diagrams

cies of bamboo are well adapted, and the raw materials with which this potential new source of pulp must compete.

American hardwoods (Fig. 3) are relatively short fibered (1–2 mm.). Hardwood fibers are quite broad in relation to their length; length-diameter ratios range from 25 to about 75 with the ratios for a majority of the species less than 50. The two most important broadleaved pulpwoods, gum (*Liquidambar styraciflua* L.) and aspen (*Populus tremuloides* Michx.), are indicated separately in the diagram. These two species combined make up about 65% of the hardwoods pulped in the United States.

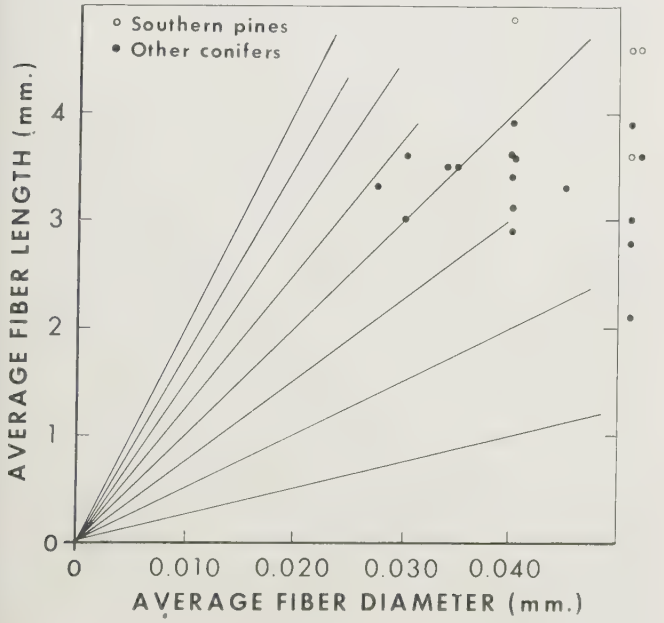


Fig. 2. Wood of American coniferous trees

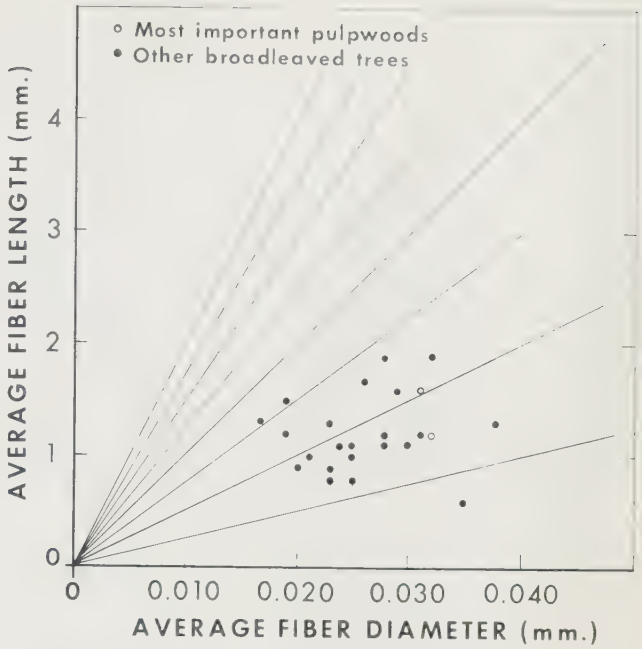


Fig. 3. Wood of American broadleaved trees

FIBERS OF MONOCOTYLEDONS

Fibers of Bamboos

Species of bamboo (Gramineae: tribe Bambuseae) are represented in Fig. 4. Two important groups are distinguished, the rhizomatous or "running" bamboos (*Arundinaria, Phyllostachys,* etc.) and the caespitose or "clump-type" bamboos (*Bambusa, Dendrocalamus,* etc.). The rhizomatous bamboos produce new culms from underground rhizomes which extend out in all directions from the original planting, and spread rapidly. The caespitose bamboos produce new culms from the base of existing culms. They do not spread but in time form large clumps.

The rhizomatous bamboos are, in general, well adapted to growth in the southeastern United States and along the Pacific Coast and are able to tolerate rather low winter temperatures. They are one of the

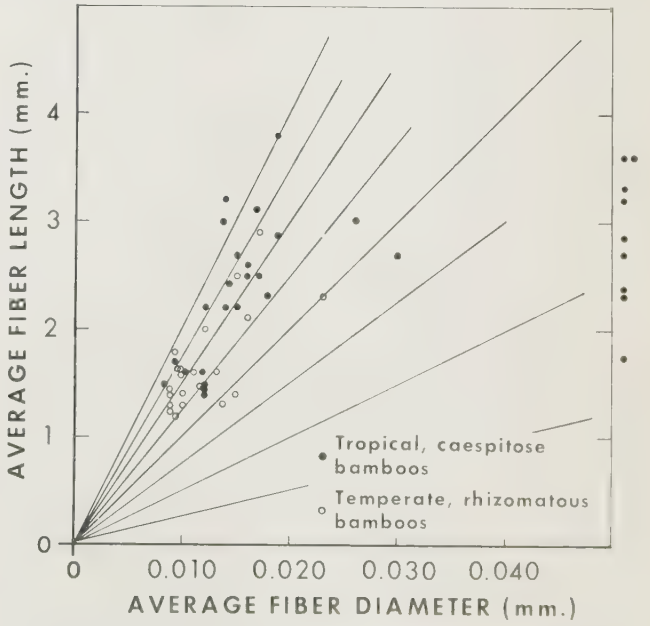


Fig. 4. Whole stems of Gramineae, tribe Bambuseae

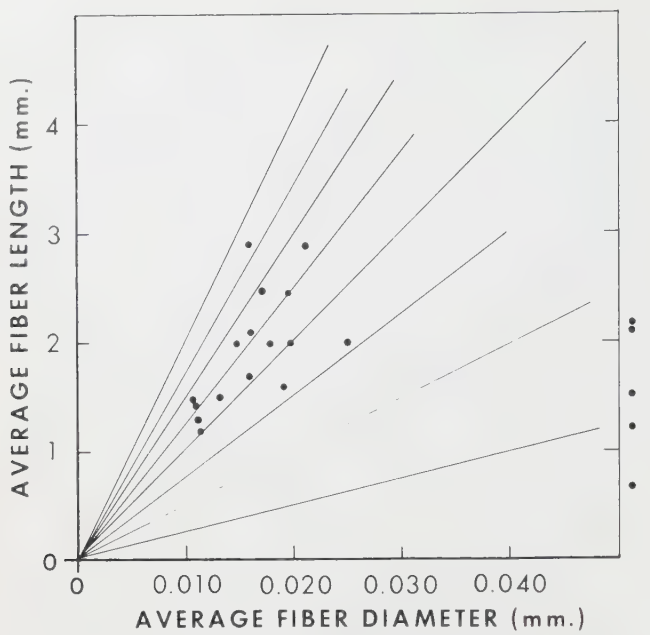


Fig. 5. Whole stems of Gramineae, tribe Andropogoneae

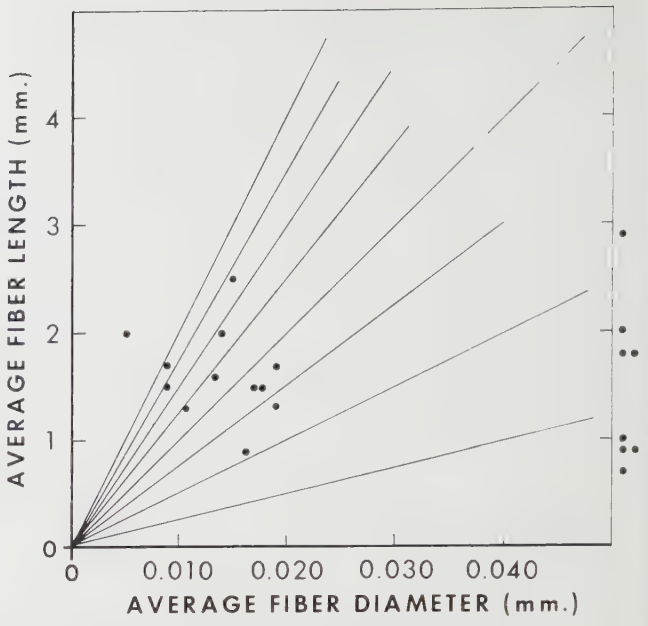


Fig. 6. Whole stems of Gramineae, tribes other than Bambuseae and Andropogoneae

most promising potential new sources of paper pulp for the United States. The caespitose bamboos generally are unable to withstand subfreezing temperatures, and are well adapted to growth only in tropical and subtropical regions.

In fiber length the bamboos fall naturally into two groups. The caespitose species are medium- to long-fibered (1.4–3.8 mm.) and generally compare fairly well with American softwoods in this respect. Their fibers are superior to those of American hardwoods. The rhizomatous bamboos are short- to medium- fibered. Most are considerably shorter fibered than American softwoods. They compare favorably with American hardwoods and several are superior to the latter in fiber length.

Collectively, the bamboos exhibit fiber length-diameter ratios that are quite high. Most fall within the range of 125 to 200 and many exceed 150. In this quality bamboo fibers are better than American softwoods and far superior to American hardwoods. This quality should admirably adapt bamboo pulps to the production of strong thin papers with maximum smoothness and minimum porosity. Fiber length-diameter ratios of the caespitose bamboos are, on the whole, somewhat higher than those of the rhizomatous bamboos, but this difference does not appear to be great enough to be of any economic significance.

The longest recorded average fiber length for a rhizomatous bamboo is for *Sasa kurilensis* (Rupr.) Makino & Shibata (*10*), a Japanese species. Samples of this species from plants grown in the Belgian Congo are reported to have an average fiber length of 2.9 mm. On the other hand, samples from plants collected in the native habitat of the plant are reported to have an average fiber length of 1.3 mm. (*11*). This discrepancy may be due to erroneous identification or difference in methods of analysis.

S. kurilensis grows in the mountains of Hokkaido, the northernmost Japanese island, an area of rigorous winter climate. From the standpoint of climatic homologues, this species appears to be well adapted to the colder areas of the eastern United States. However, in Japan, this bamboo is completely covered by snow during the coldest part of the winter, and it is possible that this cover may provide the necessary protection from the cold temperatures and that the species would not be adaptable to areas of the United States with similar low temperatures but lacking adequate snow cover. *S. kurilensis* has been introduced to the United States only very recently and as yet we do not know of its adaptability to our environmental conditions.

Another rhizomatous bamboo of fairly long fiber length and thus of considerable interest is *Phyllostachys makinoi* Hayata, native to the mountains of Taiwan (*12*). This species, reported to have an average fiber length of 2.5 mm., is a member of a genus which contains many species that appear to be adaptable to cultivation in a large area of the southeastern U. S.

Arundinaria alpina K. Schum., reported to have an average fiber length of 2.3 mm., is native to the mountains of east Africa (*13*). This rhizomatous bamboo has not yet been evaluated in the United States.

Fibers of Grasses Other than Bamboo

Stem fibers of grasses, tribe Andropogoneae, are represented in Fig. 5, and other tribes are represented in Fig. 6. Collectively, these grasses have fairly high length-diameter ratios, greater than those of wood fibers. The fibers range from short to fairly long. On the basis of the limited data available, the members of the tribe Andropogoneae seem to offer better quality fibers than those of other tribes, exclusive of the bamboos. The most favorable grasses appear to be species of *Cymbopogon, Hyparrhenia, Saccharum,* and *Sorghum.* Most of these species with fiber lengths greater than 2.0 mm. are natives of tropical or subtropical regions. The tribe as a whole is largely distributed in warm regions but is well represented in temperate areas. It includes many genera with species that are large and coarse and produce large quantities of dry matter. The grass family in general should receive careful attention as a potential source of pulp materials. Special attention should be devoted to the bamboos and members of the tribe Andropogoneae.

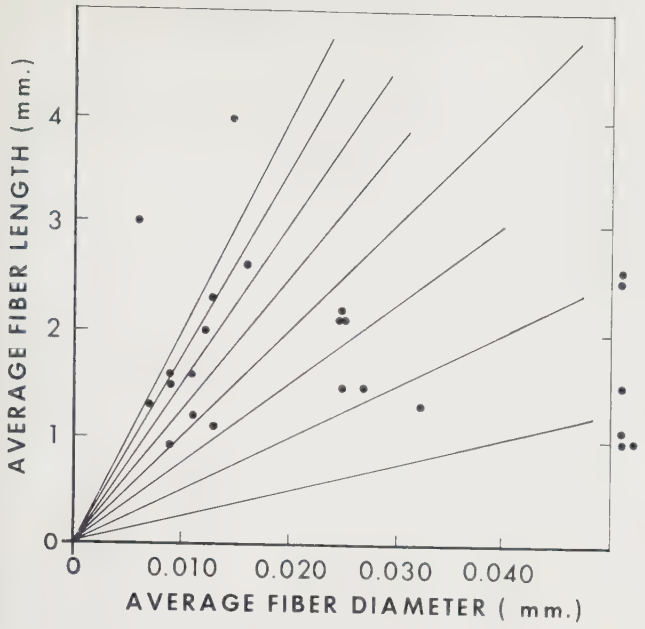


Fig. 7. Whole stems of monocotyledons other than Gramineae

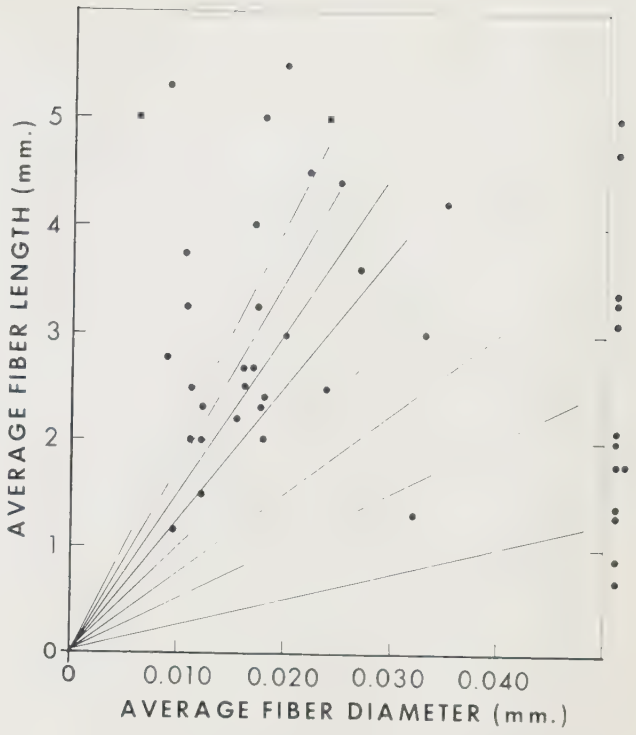


Fig. 8. Leaf fiber of monocotyledons

Stem Fibers of Other Monocotyledons

Analyses for whole stems of monocotyledonous plants other than grasses are represented in Fig. 7. Many of the species represented here are members of the family Cyperaceae. Other families represented are Araceae, Naiadaceae, Juncaceae, and Typhaceae. The dimensional characteristics of most of the fibers of these plants are similar to those of the grasses. The fibers of species of Cyperaceae are desirable materials for use in paper, but most of these plants are inhabitants of marshes or other wet areas that are not well adapted to agricultural use. The other materials represented here are either of tropical origin or similarly restricted to wet environments.

Leaf Fibers

Leaf fibers of monocotyledons represented in Fig. 8 encompass the group of materials familiar to the fiber industry as "hard fibers." Represented in the diagram are such well-known fiber-producing families as Amaryllidaceae (*Agave, Furcraea*), Bromeliaceae (*Aechmea, Ananas, Bromelia, Neoglaziovia*), Liliaceae (*Phorium, Sansevieria, Yucca*), and Musaceae (*Musa, Heliconia, Ravenala*).

These hard-fiber producing plants are almost exclusively tropical. Most are adapted only to the warmest regions of the United States. *Yucca* and *Phormium* are notable exceptions.

As a group the hard fibers are papermaking materials *par excellence*. The fibers are mostly long and narrow with high to very high length-diameter ratios.

The hard fibers of commerce consist of large bundles of tissue containing many overlapping individual fiber cells. They are imbedded in the pulpy tissue of large succulent leaves. The nonfibrous portion of the leaf is worthless as an economic source of any form of cellulose. Extraction of the fiber is relatively expensive and yield of dry fiber in relation to green weight of the leaves is low, in the range of 2 to 5%. The high cost of production of hard fibers precludes their use in other than products of the highest value. As they are of such great value for manufacture of cordage, very little reaches the paper industry.

On the whole, fibers of monocotyledons are well adapted to manufacture of paper. Of this great group of plants, the grasses seem to offer the greatest potential as a source of raw material that can be produced within the United States proper. Many species of this family are well adapted to environmental conditions within the United States and are highly productive of dry matter. Other families of monocots can be generally ruled out of consideration because (1) their fibers are produced in small quantity as structural elements of fleshy leaves and are well adapted for utilization in the manufacture of more valuable products (Amaryllidaceae, Bromeliaceae, Liliaceae, Musaceae, etc.); (2) they are largely of tropical origin and not well adapted to growth in the United States (Araceae, Zingiberaceae, etc.); and (3) they are well adapted to temperate environments but, as far as we know, only to low wet marshlike areas that are generally unsuitable for modern agricultural practices (Cyperaceae, Typhaceae, etc.). It is very unlikely that any family of monocotyledons other than the true grasses can be adapted to agricultural production in temperate areas of the U. S.

FIBERS OF DICOTYLEDONS

Fiber-dimension data are much more limited for the dicotyledons than for the monocotyledons. This is especially evident when we consider that more than half of our data pertain to the latter group, which makes up only one-sixth to one-fourth of the families, genera, and species of higher plants. Less than 200 species of dicotyledons are considered, a very poor representation for a group that includes perhaps more than 250,000 species. Woody plants, however, beyond the scope of this paper, make up a large proportion of the total number of dicotyledons. In addition to the poor representation of the species, some of the data are not complete for the species included.

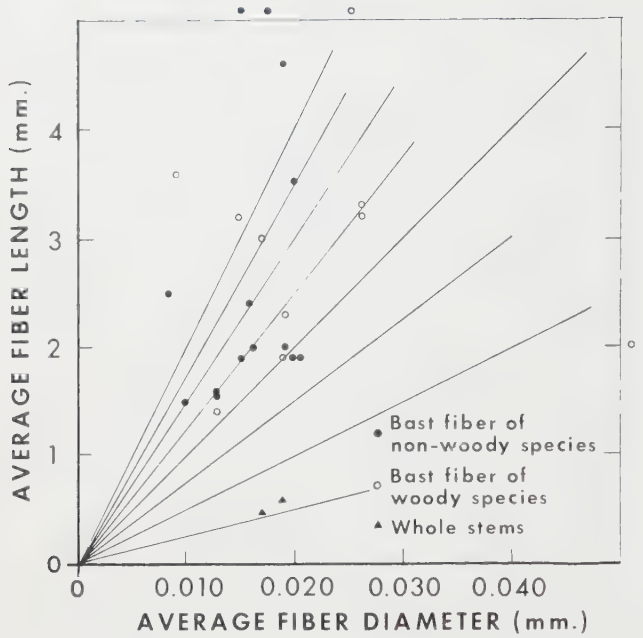


Fig. 9. Bast fiber and whole stems of Malvaceae

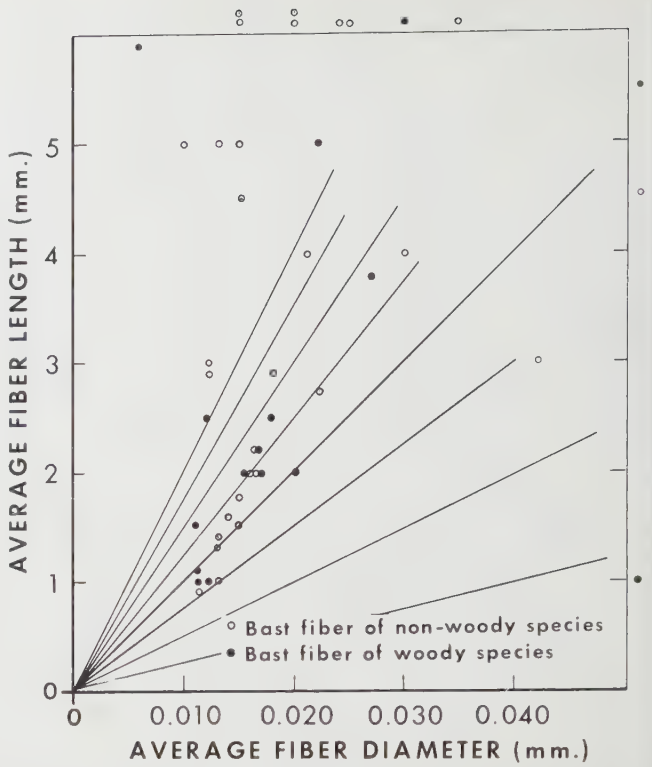


Fig. 10. Bast fiber of dicotyledons other than Malvaceae

Dicotyledons, both herbaceous and woody, characteristically consist of two different components, a cylindrical woody core and an outer flexible layer—the bast. The woody core makes up 90 to 95% of the total weight of most dicotyledon stems (*14*). In some well-established fiber plants it is considerably less, 80 to 85% in flax, about 80% in kenaf (*Hibiscus cannabinus* L.), as little as 75% in common hemp (*Cannabis sativa* L.) (dry-weight basis). The bast of dicotyledons is the source of the commercial "soft fibers." These fibers consist of large bundles or strands of tissue containing many overlapping individual fiber cells.

A great many of the available analyses are for bast fibers and do not take into account the fibers of the central woody core. With the data at hand it is impossible to make a complete appraisal of the pulp potential of the dicotyledons, but certain trends can be noted, and it is possible to arrive at certain conclusions related to dicotyledons as a whole.

Fiber of the Bast of Dicotyledons

Bast fibers of species of Malvaceae are represented in Fig. 9 and those of other families of dicotyledons are represented in Fig. 10. The latter diagram does not include the very long-fibered families such as Apocynaceae (about 25–50 mm.), Asclepiadaceae (15–30 mm.), Linaceae (a single species, about 25 mm.), Moraceae (mostly 10–20 mm.), and Urticaceae (mostly 10–40 mm.), the fibers of which are too long to be represented on the scale used in the diagrams.

Average fiber lengths of the bast components are highly variable, but on the whole they are quite long (2 mm. or greater.) Length-diameter ratios are characteristically high. Even for bast fibers of relatively short average fiber length, most length-diameter ratios are above 100.

There appears to be no general tendency for woody plants to produce longer bast fibers than those produced by nonwoody plants or vice versa. This appears to be true in a comparison of families that are primarily woody with those that are primarily herbaceous. It also appears to be true in a comparison of woody and herbaceous plants within the same family.

Most bast fibers would provide a very satisfactory material for manufacture of paper. Many species produce bast fibers with very desirable length and length-diameter ratios that would be adaptable to use in the preparation of high-quality, strong, thin papers. The low yield of bast fiber in relation to total amount of stems produced is, however, a decided disadvantage. Where a bast fiber can be produced as an economical primary product the demand for its use as a spinning fiber would probably preclude its use by the paper industry.

The Malvaceae are of particular interest among the better known soft-fiber sources. Plants of this family, as a group, produce a higher content of bast fiber than do plants of most other families. Malvaceae are particularly abundant in the tropics but are well represented in temperate areas. Some tropical and subtropical species such as cotton and kenaf can be grown as annuals in temperate areas. Species of Malvaceae are important local sources of fiber in many areas of the world. The fiber from only a few species enters commerce.

Fibers of the Woody Core of Dicotyledons

Dimensions of the fibers of the woody core of herbaceous dicotyledons are represented in Fig. 11. These fibers are very short and relatively broad. Length-diameter ratios are low. The fibers are considerably shorter than those of wood of broadleaved trees but closely comparable in length-diameter ratio. These data are very meager but the pattern indicated here is in agreement with more extensive data reported elsewhere (*7*).

As the woody core makes up such a large portion of the total weight of dicot stems, fiber dimensions of this constituent are a key factor in determining which

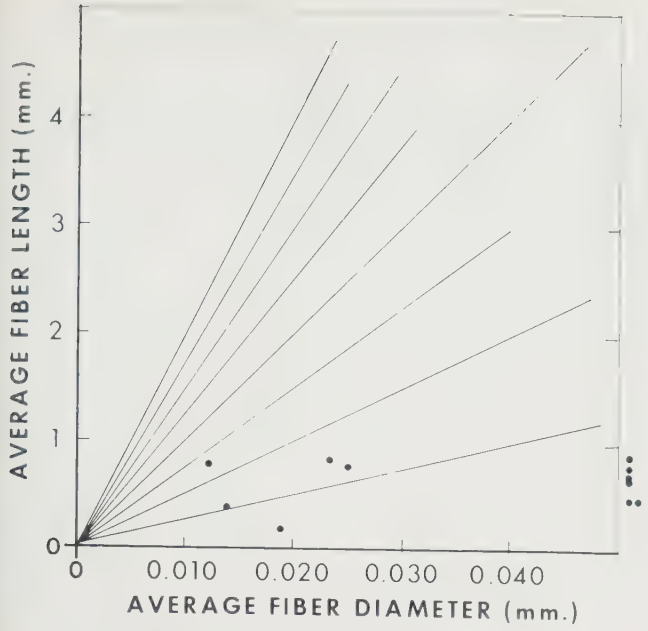


Fig. 11. Woody core of herbaceous dicotyledons

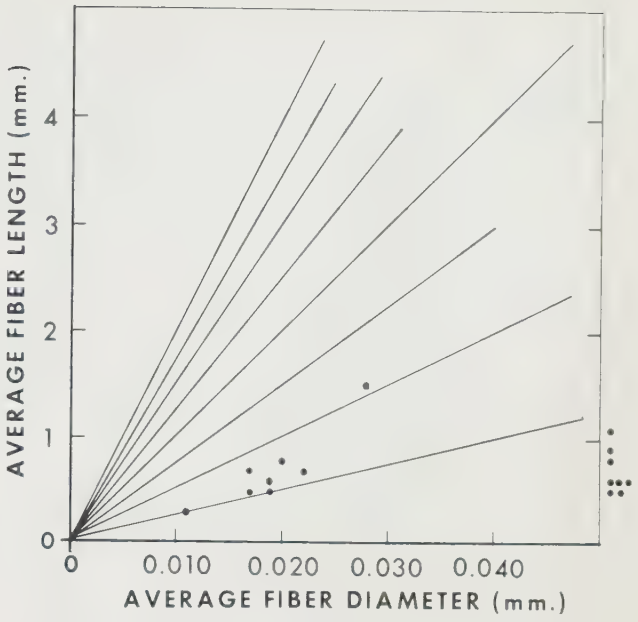


Fig. 12. Whole stems of herbaceous dicotyledons

dicotyledons offer the greatest potential as sources of paper pulp. As the fibers of the woody core are so small, they undoubtedly make up an even larger portion of the whole stems when considered by number than when considered by weight.

Even with extensive screening of herbaceous dicotyledons it is doubtful that a plant will be found with a woody core having fibers longer than those of broadleaved trees. In the course of evolution, most herbaceous dicotyledons were derived from woody ancestors, primarily through decrease in activity of the vascular cambium. Typical herbaceous dicotyledons are much like one-year-old stems of related woody species. They differ from woody relatives more in duration than in structure. Certain herbaceous dicotyledons, when grown under favorable climatic conditions, continue growth beyond a single season. The stem structure of these plants becomes almost identical with that of typical woody plants.

Fibers of Whole Stems of Dicotyledons

Fiber dimensions of whole stems of herbaceous dicotyledons, taking into consideration both the fibers of the bast and those of the woody core, are indicated in Fig. 12. The effect of the short-fibered woody core on the average fiber dimensions of whole stems is illustrated by this diagram and Figs. 9 to 11. While average lengths and average length-diameter ratios for bast fibers are high (Figs. 9–10), when fibers of the bast and woody core are averaged together (Fig. 12) the values are very low, almost as low as for the woody fibers alone (Fig. 11).

The data for fiber dimensions of whole stems of dicotyledons are very limited. The general pattern indicated here, however, is the same as that indicated by more extensive data collected by the current U. S. D. A. fiber-screening program (*7*).

For consideration of the pulping potential of herbaceous dicotyledons, fiber analyses are needed for both the fibers of the bast and the fibers of the woody core. While it is possible that these materials can be separated and utilized independently, any large-scale production of one of these plants for manufacture of pulp will probably depend on the utilization of whole stems. A pulping method which can at the same time produce quality pulp from both the bast and woody core will, with appropriate plants, result essentially in upgrading the short fibers of the woody core with the longer fibers of the bast. It is possible that the bast and woody core can be separated mechanically, pulped separately, and then recombined as a blend, but this will probably not be economical unless for some special-purpose paper of higher than usual value. It also may be feasible to utilize the bast of an appropriate dicotyledon as a raw material for paper and the short-fibered woody core as a source of raw material for rayon pulp. For the latter end use, fiber dimensions are not an important factor.

POSSIBLE IMPROVEMENT OF FIBER CHARACTERISTICS

The possibility of improving the properties of potential paper plants through breeding and selection offers a great challenge to agricultural scientists. Some consideration has been given to the development of improved varieties of trees with characteristics especially adapted to the manufacture of better quality pulps and papers (*15*). Fiber length, wood density, and other factors appear to be governed by genetic factors and can probably be improved by modern breeding techniques. Nonwoody plants with one complete life cycle per year, or under artificial conditions too, are far more adaptable to a breeding program than tree species.

It is impossible to assess the possible extent of improvement of pulping qualities through breeding because no work of this type has been attempted and only a small amount of research has been conducted on factors closely related to pulping properties. Possible avenues of approach include research to increase long fiber content and increase average fiber length of monocot stems and the woody core of dicots. Improvements in chemical properties such as increase in total cellulose are also possible. It may be possible through breeding to narrow the differences in the pulping properties of the bast tissue and woody core of herbaceous dicots.

U.S.D.A. scientists have nearly doubled the fiber content of selected strains of species of *Sansevieria*. A breeding program in Germany, between 1919 and 1938, increased the fiber content of *Urtica dioica* L. from about 4–5% to 15% (*16*). Such spectacular increases in fiber content are more likely to be achieved in plants not presently under cultivation than in those which have been long cultivated and constantly subjected to improvement by selection.

Increase in fiber content has been one objective of breeding programs on flax and common hemp. Some success has been attained but increases are by no means as great as that attained with *Urtica dioica*. Both flax and hemp have been cultivated for centuries and subjected during this time to improvement by selection of seed from superior plants.

It has been the experience of the U. S. D. A. plant breeders that high fiber content in flax is often accompanied by weakness of stems and consequent lodging, due apparently to the decrease in size of the stem-supporting, stiff woody core. This problem may be a limiting factor in establishing the maximum bast-fiber content of certain herbaceous dicotyledons but can possibly be overcome.

No experience has been gained on the effect of such factors as polyploidy and hybrid vigor on fiber characteristics, or characteristics related to fiber properties.

CONCLUSIONS

In spite of the sparse amount of data on fiber dimensions, several very general conclusions can be noted which have direct bearing on the problem of discovering a nonwoody plant which can be cultivated as an agricultural crop within temperate areas of the United States as an economical source of paper pulp:

1. Among the plants considered in this study that are generally adapted to growing conditions in the temperate areas of the United States, greatest average fiber lengths are found in the bast fibers of dicotyledons and the stems of grasses, especially bamboos. The long fiber length of the leaf fibers is only of academic value, for plants producing these fibers are generally not adapted to temperate growing conditions.

2. Whole stems of bamboos and herbaceous monocotyledons have longer fibers than whole stems of herbaceous dicotyledons. For large-scale production of an agricultural crop as a source of raw material for other than special-purpose high-value pulps, a plant must be evaluated on the basis of the quality of the entire stem. From the standpoint of fiber dimensions it appears that a monocotyledon will have a greater chance of being accepted as a pulp material than will a dicotyledon.

3. The woody core of dicotyledons is typically very short fibered.

4. With a few exceptions the bast fibers of families of dicotyledons have desirable dimensional characteristics. The bast fibers of many species are so outnumbered by the short fibers of the woody core that they have relatively little effect on the average dimensions of the fibers of whole stems. It appears that the most useful dicotyledons will thus be those which have a large content of bast fiber or a woody core with fibers of unusually large average length, preferably a combination of these two factors. For dicotyledons with only small amounts of bast, study of the fibers of the woody core may prove to be more rewarding than study of fibers of the bast.

5. In general, fiber length-diameter ratios are greater for those materials having longer average fiber lengths.

6. With the exception of the fibers of whole stems and the woody core of dicotyledons, the materials considered here are generally superior to coniferous and broadleaved woods in length-diameter ratio. The fibers of the woody core of dicotyledons are very inferior in length–diameter ratio to those of coniferous trees, and are more or less similar but slightly inferior to those of broadleaved trees.

7. Most of the nonwoody materials considered here that are well adapted to cultivation in temperate areas of the United States have shorter fibers than coniferous woods. Some of these plants or groups of plants have fibers of small diameter with length–diameter ratios far superior to those of coniferous woods. These qualities suggest that nonwoody plants may establish a better competitive position if they can be used for manufacture of special-quality papers for which coniferous woods are less well adapted.

Many plant families are not represented in the data on which this study is based. Other families are represented by so few species that no reliable estimate can be given of their possible usefulness. Further research on the broad problem of developing herbaceous plants as sources of paper pulp must include consideration of these groups.

LITERATURE CITED

1. Anonymous, "The Statistics of Paper—1957," New York, American Paper and Pulp Association, 1957.
2. Anonymous, "The Demand and Price Situation for Forest Products," Washington, D. C., Forest Service and Commodity Stabilization Service, U. S. Department of Agriculture, November, 1958.
3. Lathrop, E. C., The Characteristics of Pulp Fibers from Agricultural Residues, *FAO Forestry and Forest Products Studies* No. 3: pp. 143–154, Rome, Food and Agriculture Organization of the United Nations, 1952.
4. Clark, J. d'A., *Tech. Assoc. Ser.* 25, No. 1: 556–562 (1942).
5. Regie Industrielle de la Cellulose Coloniale, The Relationship between the Morphological Characteristics of the Fibers from Tropical Woods and the Quality of the Pulp and Paper Obtained from Them, "Pulp and Paper Prospects in Latin America," pages 378–380, New York, Food and Agriculture Organization of the United Nations, 1955.
6. Fuehrer, R. C., "The Effect of Average Fiber Length on Strength Properties of Handsheets," Thesis, Department of Chemical Engineering, University of Maine, Orono, Me., May 1958.
7. Nieschlag, H. J., Nelson, G. H., Wolff, I. A., and Perdue, R. E., Jr., *Tappi* 43, No. 3: 193–201 (1960).
8. Isenberg, I. H., "Pulpwoods of the United States and Canada," Appleton, Wis., The Institute of Paper Chemistry, 1951.
9. Sutermeister, E., *Pulp & Paper Mag. Canada* 12, No. 1: 43–44 (1914).
10. Istas, J. R., Heremans, R., and Raekelboom, E. L., *Bull. Agr. Congo Belge* 47, No. 5: 1299–1325 (1956).
11. Fukuyama, G., Kawase, K., and Satonaka, S., *Res. Bull. Coll. Exp. For., Hokkaido Univ.* 17, No. 2: 271–293 (1955).
12. Takenouchi, Y., "Take No Kenyu" (Studies on the Bamboos), 1932.
13. Anonymous, "Memorandum on the East African Bamboo (*Arundinaria alpina*) with Special Reference to Its Utilization for the Manufacture of Paper Pulp," Forest Department, Kenya Colony and Protectorate, March 1922.
14. Bredemann, G., *Faserforschung* 14: 105–112 (1939).
15. Dadswell, H. E. and Wardrop, A. B., *Appita* 12, No. 4: 129–136 (1959).
16. Bredemann, G., *Faserforsch. u. Textiltech.* 4, No. 1: 33–36 (1953).

Received May 12, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Preliminary Report on the Fungous Flora of Pulp and Paper in New York

C. J. K. WANG

This is a preliminary report on the fungi isolated from pulp and paper samples collected at monthly intervals in four representative New York mills, in 1959. Forty-three species and 12 genera, representing two-thirds of over 900 isolates obtained, are recorded in this paper. Eight genera were found to be commonly present in pulp suspensions collected from the headboxes or cylinder vats. *Heterosporium terrestre*, *Paecilomyces varioti*, *Phialophora mustea*, and *Beauveria bassiana* are reported for the first time from pulp suspensions. Implications of the presence of these fungi in pulp and paper mills are discussed.

Slime deposits may accumulate during the manufacture of paper in various locations in the machines. These deposits, consisting of bacterial colonies and fungous hyphae matted together with fibers and debris, interfere with the performance of equipment and degrade the product. Expensive efforts are made to control these organisms whose population in pulp or slimes may be determined by such factors as nutrient and oxygen supplies, moisture content, temperature, toxicants used, and the interaction of microorganisms. Efficient control must consider the factors favoring their growth. Reports, however, have shown that chemicals added to reduce the microflora frequently altered the microbiological balance and induced the formation of slimes of different color and texture that were even more troublesome than the original (*9*). Each species has specific effects, and accurate determination of the organisms present is a necessary step to provide information essential to efficient slime control. Numerous investigations on the role and control of microorganisms in slime formation during paper manufacture have emphasized the slime-forming bacteria; extensive and thorough taxonomic studies of the fungi concerned are rare. The purpose of the present investigation was to determine the species and frequency of fungi that were found in representative pulp and paper mills in New York state.

MATERIALS AND METHODS

Pulp and paper samples were collected monthly, from May to November, 1959, from four pulp and paper mills representative of the types of furnish used and product manufactured in central New York (Table I).

Three pulp samples were collected aseptically at each mill from the headbox or cylinder vat, and placed in French squares. Three paper samples were taken at the reel at each mill by means of sterile forceps and shears, and were stored in sterile crystallizing dishes. All samples were kept at 5°C. until plating.

C. J. K. Wang, Research Associate, Forest Botany and Pathology Department, State University College of Forestry at Syracuse University, Syracuse, N. Y.

Numbers and kinds of fungi in pulp and paper samples were determined by the quantitative dilution plate method recommended by the Technical Association of the Pulp and Paper Industry (*18*), with minor modifications to suit the present need. The culture media used were Difco malt agar, Difco potato dextrose agar and, for isolation of Actinomycetes, Bennett's medium as recommended by Professor Carlos Carpenter of Syracuse Research Corp. (personal communication).

All plates were incubated at room temperature. Fungous colonies were studied weekly; at the end of four weeks each type of colony was provisionally identified, counted, and obtained in pure culture. Identification of fungi was based on the characteristics of cultures center-inoculated in Petri plates containing suitable media. Slide cultures of many fungi were prepared according to Taschdjian's technique (*17*) for better observation of the conidial structures.

All cultures are being maintained in the Department of Forest Botany and Pathology, State University College of Forestry at Syracuse University.

RESULTS

Approximately two-thirds of the total of 949 isolates have been studied, and the species identified are presented in this preliminary paper. The exact numbers and varieties of fungi in pulp and paper samples and their distribution at various seasons must await the identification of all isolates; these will be reported later.

The following list of fungi is presented in the usual scheme of taxonomic classification. Fungi isolated more than 10 times are considered frequent or common; those isolated less than 10 times are considered infrequent.

Actinomycetes

Four species of *Streptomyces* and two species of *Micromonospora* were segregated, but specific identification has not been completed.

Phycomycetes

These fungi were encountered infrequently:

1. *Absidia butleri* Lendner.
2. *Absidia corymbifera* (Cohn) Sacc. & Trott.
3. *Mucor hiemalis* Wehmer.
4. *Rhizopus arrhizus* Fischer.
5. *Rhizopus stolonifer* (Ehrenb. ex Fr.) Vuill.
6. *Syncephalastrum racemosum* Cohn ex Schroet.
7. *Mortierella* sp.

Ascomycetes

1. *Byssochlamys fulva* Olliver & Smith. From two mills. The imperfect stage of this fungus was

frequently isolated from all four mills (see *Paecilomyces varioti* under Fungi Imperfecti).

2. *Chaetomium indicum* Corda. Infrequent.

3. *Eurotium repens* De Bary. Infrequent.

4. *Sartorya fumigata* Vuill. This species was isolated more often from paper samples than from pulp.

5. *Talaromyces vermiculatus* (Dang.) C. R. Benjamin. From two mills.

Basidiomycetes

Nine isolates with clamp connections are considered Basidiomycetes, and 40 additional isolates have the gross cultural appearance of basidiomycetes; clamp connections or basidia, however, are lacking. None of these has been identified.

Table I. Products, Slimicides, and Furnish Typical for Central New York Mills

Mill	*Product*	*Slimicide*[a]	*Furnish*
1	Coated book paper	Merfenel	Groundwood, sulfite
2	Towel and tissue	Chlorine in fresh water, Butrol, or Crag 974	Waste, occasionally groundwood, sulfite
3	Lined chip, bleached manila	Chlorine in fresh water, Busan 881	Waste
4	Food board	Chlorine in fresh water and in white water	Bleached Kraft or groundwood

[a] Active ingredients of slimicides: Busan 881—12.7% disodium cyanodithioimidocarbonate, 4.8% ethylenediamine and 17.5% potassium *N*-methyldithiocarbamate. Butrol—10% phenylmercuric acetate and 50% potassium *o*-phenylphenate. Crag 974—100% 3,5-dimethyltetrahydro-1,3,5,2H-thiodiazine-2-thione. Merfenel—85% phenylmercuric acetate.

Fungi Imperfecti

1. *Aspergillus flavus* Link. Infrequent.

2. *Aspergillus fumigatus* Fres. A very common species, particularly abundant in September in all four mills.

3. *Aspergillus niger* van Tiegh. Common in both pulp and paper samples. This fungus is employed frequently as a testing organism for evaluating slimicides (*1*, *20*).

4. *Aspergillus repens* (Corda) de Bary. Infrequent.

5. *Aspergillus sydowi* (Bain. & Sart.) Thom & Church. Infrequent.

6. *Aspergillus terreus* Thom. Infrequent.

7. *Aspergillus unguis* (Emile-Weil & Gaudin) Thom & Raper. Infrequent.

8. *Aspergillus versicolor* (Vuill.) Tirab. Infrequent.

9. *Beauveria bassiana* (Bals.) Vuill. Isolated once from the headbox of a local mill during a preliminary routine study and once from a pulp sample from one mill. *Beauveria bassiana*, known previously as a parasitic, entomogenous fungus (*3*, *10*), may be a saprophyte as well, as indicated by this isolation from pulp.

10. *Cladosporium cladosporioides* (Fres.) de Vries. This and the following species of *Cladosporium* were very common. Robak (*16*) reported that these two species of *Cladosporium* were the most abundant ones found in Norwegian mills, and the latter was also frequently isolated as a blueing fungus in pulpwood in Sweden (*12*), and from slime in Swedish (*13*) and British (*14*) mills.

11. *Cladosporium herbarum* Link ex Fr.

12. *Geotrichum candidum* Link ex Pers. Isolated every month from both pulp and paper samples in all four mills. This species was common in groundwood pulp in Sweden (*12*), and in slime accumulations in Britain (*14*) and Canada (*4*).

13. *Gliocladium deliquescens* Sopp. Infrequent.

14. *Heterosporium terrestre* R. G. Atkinson. Very abundant in pulp samples in three mills. This species, a soil fungus isolated by Atkinson (*2*) from Ontario, Canada, is here reported for the first time from pulp suspensions.

15. *Hormodendron cladosporioides* (Fres.) Sacc. This fungus, obtained frequently in pulp samples from one mill, was identified by Dr. Hughes.

16. *Margarinomyces heteromorpha* (Nannf.) Mangenot. Common in all four mills. According to Melin and Nannfeldt (*12*), this species was one of the important blueing fungi in wood pulp in Sweden.

17. *Oidiodendron griseum* Robak. From pulp samples from one mill. Robak originally described this and the following species from Norwegian (*16*) and Swedish (*12*) pulp mills. Dr. Hughes has confirmed the identity of my isolates.

18. *Oidiodendron nigrum* Robak. From pulp and paper samples from one mill.

19. *Paecilomyces varioti* Bain. Frequently isolated from pulp and paper samples from all four mills. It has not been reported previously from this environment. This fungus has been found in hardwoods (*6*, *15*) and in polluted water (*5*).

20. *Penicillium thomii* Maire. Infrequent.

21. *Periconia minutissima* Corda. Infrequent.

22. *Phialophora fastigiata* (Lagerberg & Melin) Conant. From one mill Robak (*16*) isolated *P. fastigiata* from Norwegian wood pulp, and Melin and Nannfeldt (*12*) found it to be one of the most common species in air, fresh water, white water, and groundwood pulp from 16 mills in Sweden. It was also reported by Brewer (*4*) as the most frequent fungus in slime from mills in New Brunswick and Newfoundland.

23. *Phialophora lagerbergii* (Melin & Nannf.) Conant. Found once in a paper sample from a single mill, and not previously reported on pulp or paper. This species causes blue stain of pine in Sweden (*12*).

24. *Phialophora mustea* Neergaard. This was the most widely distributed and most common organism in pulp samples from all four mills. It has not been reported from this habitat by other investigators. The original isolate was from cider in Europe (*19*). Dr. Hughes confirmed the identification and indicated that the isolate differs slightly from the type material by its irregular-shaped chlamydospores.

25. *Phialophora richardsiae* (Nannf.) Conant. From two mills. This species has been reported previously from groundwood pulp in Sweden (*12*), and from slime accumulations in Newfoundland and New Brunswick mills (*4*).

26. *Phialophora verrucosa* Medlar. This fungus, which causes chromoblastomycosis in man (*11*), was found in pulp samples from two mills. It was not found in the paper product. This organism has previously been isolated from groundwood pulp in the United States (*12*).

27. *Pullularia pullulans* (de Bary) Berkh. Encoun-

tered only occasionally in the present study. A ubiquitous organism, *P. pullulans*, came from air, fresh water, white water, and groundwood pulp in Sweden (*12*), from slime in Norwegian mills (*16*) and in British mills (*14*).

28. *Rhinocladiella atrovirens* Nannf. From one mill. Melin and Nannfeldt (*12*) isolated it in white water from two Swedish mills. Brewer (*4*) found it the predominant fungus of those isolated from slime accumulation in the groundwood riffler box in a New Brunswick mill.

29. *Sporobolomyces salmonicolor* (Fisch. & Brebeck) Kluyver & van Niel. Infrequent.

30. *Trichoderma album* Preuss. Infrequent.

31. *Trichoderma koningi* Oudem. This and the following species were very common.

32. *Trichoderma lignorum* (Tode) Harz.

Incompletely Identified

The following genera are represented in the approximately 400 cultures at present incompletely identified.

1. *Alternaria*, several species. Common in pulp and paper samples in all four mills.
2. *Fumago*-like fungus, one species. Infrequent.
3. *Fusarium*, several species. From three mills.
4. *Hemispora*, one species. Infrequent.
5. *Leptographium*, one species. Infrequent.
6. *Menispora*, one species. Infrequent.
7. *Papularia*, one species. Infrequent.
8. *Penicillium*, many species. Very common in pulp and paper samples in all four mills.
9. *Rhodotorula*, one to several species. From all four mills.
10. *Sporotrichum*, one to several species. From one mill. Infrequent.

DISCUSSION

Bacteria were outside the scope of the present study; they were observed, however, in abundance in most sample isolations.

In the Actinomycetes *Micromonospora* spp., found both in pulp and paper, were common in three mills. Species of *Streptomyces*, isolated mostly from pulp samples, were common in a single mill, and the total number of Actinomycetes in this mill was high in comparison with the total number of fungi there.

The abundance and certain characteristics of these Actinomycetes suggests that these organisms deserve intensive study of the role they play in the manufacture of paper. The well-known antibiotic activity of certain species of *Streptomyces* warrants research to determine if the species isolated were having such an effect on the sparse population of fungi at one mill. Some of the *Streptomyces* isolated produce intense stain in cultures, and colonies of *Micromonospora* spp. possess orange and brown pigments, which might affect the value of paper. The musty smell, characteristic of Actinomycetes, could be one of the causes of the unpleasant odors sometimes found in pulp and paper. The relationship between Actinomycetes and slime formation is inadequately treated in the literature and should be investigated.

Phycomycetes and Ascomycetes were relatively infrequent, as was found in the British slime flora (*14*). *Sartorya fumigata* may have been an air contaminant as it was recovered more often from the paper samples than from the pulp. *Byssochlamys fulva*, including its imperfect stage *Paecilomyces varioti*, is a fast-growing, abundant, yellow-green cosmopolitan species. The relation of this fungus to the discoloration of paper and slime accumulation should be studied.

The imperfect fungi were more abundant in number and variety than that of any other group of fungi. The species most frequently isolated from pulp samples as well as from paper and board were *Aspergillus fumigatus*, *A. niger*, *Cladosporium cladosporioides*, *C. herbarum*, *Geotrichum candidum*, *Alternaria* spp., *Paecilomyces varioti*, and *Penicillium* spp. Contamination by these organisms has been considered to be mainly from air and fresh water (*5, 7, 8*). The number of these fungi found in paper and board was very small in comparison with the number of fungi in pulp. The high temperature of the driers apparently killed most fungi in pulp suspensions as some paper or board samples were free of them. Since the paper and board could not be collected immediately after leaving the driers, the few species isolated from such samples may be contaminants from air.

The eight genera of fungi most commonly isolated from pulp suspensions collected from the headboxes or cylinder vats were *Heterosporium terrestre*, *Hormodendron cladosporioides*, *Margarinomyces heteromorpha*, *Paecilomyces varioti*, *Phialophora* spp., *Trichoderma* spp., *Fusarium* spp., and *Sporotrichum* spp. These may come from fresh water, air, white water, or pulp (*5, 7, 8, 12*).

Several species have properties whose effect on papermaking should be investigated. *Phialophora mustea*, *Margarinomyces heteromorpha*, and *Heterosporium terrestre*, common in all or nearly all the mills, were apparently uncontrolled by the various types of slimicides employed. All three fungi formed dark colonies and the first two species were fast-growing and slimy. These species have not been reported associated with slime formation.

Other species of *Phialophora*, previously associated with timber, wood pulp, and slime accmulations (*4, 12*), were found in pulp suspensions composed of waste papers or box cuttings. *Pullularia pullulans*, *Rhodotorula* sp., *Rhinocladiella atrovirens*, and species of *Phialophora* (except *P. mustea*), have been reported as common slime formers by other investigators (*4, 12, 14*); their infrequent isolation in the present study may be due to the use of slimicides.

The interactions of microorganisms are in need of intensive study. Melin and Nannfeldt (*12*) stated that certain yeastlike hypomycetes, e.g., the pink yeast, exercised a strong retarding action upon the growth and staining intensity of the blueing fungi (*Phialophora fastigiata*, *Rhinocladiella atrovirens*, and *Margarinomyces heteromorpha*) in groundwood pulp. According to King (*9*), chemicals added to control slime accumulation have induced the formation of slimes of a different color and texture. Slime control programs could be improved, perhaps, if they were based upon experiments on the interaction of specific organisms and on the chemicals used to control them. The role of specific fungi in odor formation, color changes, slime accumulation and their interactions must be known before truly efficient control can be devised.

LITERATURE CITED

1. Appling, J. W. and McCoy, J. F., *Paper Trade J.* 121: 37–40 (1945).
2. Atkinson, R. G., *Mycologia* 44: 813–822 (1952).
3. Benham, R. W. and Miranda, J. L., *Mycologia* 45: 727–746 (1953).
4. Brewer, D., *Canad. J. Bot.* 36: 941–946 (1958).
5. Cooke, W. B., *Sydowia, Ser. II., Beih.* 1: 146–175 (1957).
6. Davidson, R. W., Campbell, W. A., and Vaughn, D. B., U.S.D.A. Tech. Bull. 785: 1–65 (1942).
7. Gordon, M. A., *Ann. Allergy* 15: 400–408 (1957).
8. Harsh, G. F. and Allen, S. E., *J. Allergy* 16: 125–135 (1945).
9. King, G., *Pacific Pulp Paper Ind.* 18: 39–46 (1944).
10. MacLeod, D. M., *Canad. J. Bot.* 32: 818–890 (1954).
11. Medlar, E. M., *Mycologia* 7: 200–203 (1915).
12. Melin, E. and Nannfeldt, J. A., *Svenska Skogsvfören. Tidsskr.* 32: 397–616 (1934).
13. Pehrson, S., *Svensk. Papperstidn.* 50: 497–509 (1947).
14. Prendergast, A. G., *Paper-Maker* 116: TS 21–26 (1948).
15. Raper, K. B. and Thom, C., "A Manual of the Penicillia," Baltimore, The Williams & Wilkins Co., 1949.
16. Robak, H., *Nyt. Mag. Naturvidenskaberne* 71: 185–330 (1932).
17. Taschdjian, C. L., *Mycologia* 46: 681–683 (1954).
18. TAPPI Standards T 631 m-55 and T 449 m-55.
19. Van Beyma, Thoe, Kingma, F. H., and Van Leeuwenhoek, A., *J. Microb. Serol.* 9: 51–76 (1943).
20. Zabel, R. A. and O'Neil, F. W., *Tappi* 40: 911–913 (1957).

Received June 13, 1961.

This project was initiated and supported by the Forest Botany and Pathology Department, State University of New York College of Forestry at Syracuse University, Syracuse, N. Y. The author is deeply indebted to Dr. Robert A. Zabel and Dr. Josiah L. Lowe for their guidance during this investigation, and to Robert Anthony for collecting samples. She also is much obliged to Dr. Stanley J. Hughes, Senior Mycologist, Plant Research Institute, Canada Department of Agriculture, Ottawa, Canada, for the identification of fungi as indicated.

The College gratefully acknowledges the cooperation given by Carthage Paper Makers, Inc., Carthage, N. Y.; Crown Zellerbach Corp., Carthage, N. Y.; Sealright-Oswego Falls Corp., Fulton, N. Y., and St. Regis Paper Co., Deferiet, N. Y.

A Study of the Pectin Present in the Inner Bark of White Birch (*Betula papyrifera* Marsh.)

T. E. TIMELL and A. JABBAR MIAN

A pectic material has been isolated from the inner bark of white birch in a yield of 3–4%, containing *D*-galacturonic acid, galactose, and *L*-arabinose residues in a ratio of 66:7:27 and also traces of glucose, xylose, and rhamnose units. Attempts to resolve the product by various fractionation procedures were all unsuccessful. Esterification, reduction, methylation, and hydrolysis gave as main products 2,3,6-tri-*O*-methyl-*D*-galactose and 2,3,5-tri-*O*-methyl-*L*-arabinose. Free boundary electrophoresis suggested the presence of three different polysaccharides. One of these was an α-(1 → 4)-linked polygalacturonic acid of moderate molecular weight, probably branched and almost, if not entirely, devoid of neutral sugar residues. The second polysaccharide was probably composed of both galacturonic acid and neutral sugar residues, while the third appeared to be a neutral polymer. The arabinose residues were present as nonreducing end-groups in the furanose form, but the nature of the galactose and the three other sugar residues remained unknown. The results were compared with recent information on other pectic material and brief mention was made of the probable biogenesis of the pectic triad in land plants.

In previous investigations (*1*) several polysaccharides were isolated from the inner bark (secondary phloem) of white birch. The two main components, a 4-*O*-methylglucuronoxylan (*2*) and a cellulose (*3*) were fully characterized. The third most abundant constituent, a pectic material, has now been studied in more detail.

Pectin has previously been reported to occur in considerable quantities in the bark of both gymnosperms and arborescent angiosperms. Anderson and co-workers isolated various bark pectins (*4–6*), 10% being present in the inner bark of black spruce (*6*). Painter and Purves (*7*), in an exhaustive study of polysaccharides from the secondary phloem of white spruce, isolated a pectinic acid in a yield of 7% of the bark. This polysaccharide had $[\alpha]_D$ + 210° and on hydrolysis gave mostly galacturonic acid together with minor amounts of galactose and arabinose.

T. E. Timell and A. Jabbar Mian, Pulp and Paper Research Institute of Canada and the Department of Chemistry, McGill University, Montreal, Quebec.

RESULTS

The pectic material originated from two different birch trees, one felled in early October and the other in early April the following year. The brown inner bark was converted to sawdust and extracted with organic solvents. Treatment with hot water removed a mixture of polysaccharides in a yield of 1.5%, containing galacturonic acid, galactose, glucose, mannose, arabinose, and xylose residues with the xylose predominating. When the remaining bark from the autumn-felled tree was extracted with hot, aqueous ammonium oxalate, a product was obtained in a yield of 4.2% which on hydrolysis gave galacturonic acid and arabinose in a ratio of 9:1 in addition to traces of galactose, and which had $[\alpha]_D$ + 240°. This material was used in attempts to eliminate neutral sugar residues.

Repeated precipitation of the calcium pectate, followed by exhaustive washing with water or dimethyl sulfoxide gave in low yield a product containing more arabinose and galactose than the original material. Similar results were obtained on extraction of the free pectic acid or the copper salt. Partial hydrolysis with weak acids failed to eliminate the material giving rise to the arabinose residues.

A crude pectin was obtained in a similar yield from the spring-felled tree. Treatment with exchange resin gave a product in a yield of 60% which showed $[\alpha]_D$ + 210°, had uronic anhydride and methoxyl contents of 71 and 3.4%, and possessed an equivalent weight for the repeating unit of 260. Hydrolysis gave D-galacturonic acid, galactose, and L-arabinose in a ratio of 66:7:27, and also minor amounts of glucose, xylose, and rhamnose. In addition to the fractionation pro-

cedures referred to previously, fractional precipitation with cetyltrimethylammonium hydroxide in the presence of borate (*8*) was also used in attempts to alter the composition of the product. The latter, however, remained constant.

For a structural analysis, the pectic material was methylated in several experiments. Probably because of the high alkali lability of the polygalacturonic acid (*9*) yields of the methylated polysaccharide were invariably less than 10%. Since the alkali lability of the pectic acid is caused by the presence of the carboxyl groups, attempts were made to eliminate the latter by esterification with propylene oxide (*10, 11*), followed by reduction of the ester groups with sodium borohydride (*11*). After three such treatments, a product was obtained in a yield of 50% which contained 2% of uronic acid and gave galactose, glucose, and arabinose in a ratio of 58:6:36 on hydrolysis. The sugar composition shows that more of the acidic than of neutral material has been removed. The yields on esterification were quantitative, and the preferential loss of polygalacturonic acid was undoubtedly caused by the alkaline conditions prevailing during the reductions.

The reduced product (galactan) was easily methylated, first with dimethyl sulfate and alkali, and subsequently with methyl iodide and silver oxide in the presence of dimethylformamide according to Kuhn and co-workers (*12*). The final yield of the fully methylated product was 52%. The mixture of reducing sugars obtained on hydrolysis was resolved by gradient elution with aqueous ethanol on a charcoal-Celite column. The results are presented in Table I. The first two fractions were mixtures of mono- and disubstituted hexoses, and were not further examined. Fraction III consisted of 2,3,6-tri-*O*-methyl-D-galactose, identified through its crystalline lactone. Fraction V and a part of fraction VI contained a sugar which was tentatively characterized as 2,3,4,6-tetra-*O*-methylgalactose. The last fraction was 2,3,5-tri-*O*-methyl-L-arabinose, identified through its crystalline amide. The ratio between the mono-, di-, tri-, and tetra-*O*-methylgalactose and the tri-*O*-methylarabinose was approximately 0.2:1:10:1:6. The number-average D.P. of the methylated galactan as determined by osmometry was 142, while the corresponding value for the nitrate derivative of the original pectic acid was 130.

The methylation data show that the galacturonic acid residues were linked together by (1 → 4)-glycosidic bonds. The high positive rotation of the pectic acid indicates that these residues were present in the α-modification. Only one arabinose derivative could be detected and the nature of this suggested that the arabinose residues were all present as nonreducing end-groups in the furanose form. If the D.P. of the methylated galactan, 142, is compared with the number of nonreducing hexose units, one per 19, it is noted that 7 to 8 branches could be present per average macromolecule.

In an attempt to establish whether the original pectic acid was chemically homogeneous or not, the polysaccharide was subjected to free boundary electrophoresis under various conditions. In borate buffer (Fig. 1) three mobile components were observed. In this case all polysaccharides present would assume a

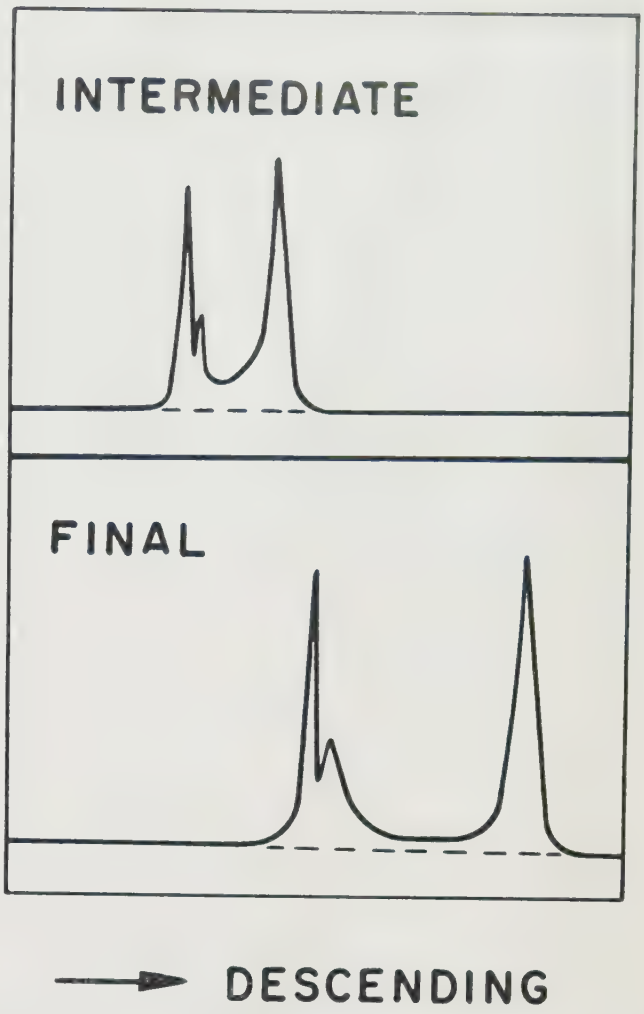


Fig. 1. Free boundary electrophoresis of pectic material in borate buffer solution

negative charge if they could form a complex with the borate. It could be expected, however, that the polygalacturonic acid would be more strongly ionized and thus have the highest mobility.

When subjected to electrophoresis in a dilute aqueous solution of sodium chloride (Fig. 2), the sodium salt of the pectic acid was also resolved into three components. The major portion traveled much faster than the remainder and had a mobility of 11.3×10^{-5} cm.^{2} v.$^{-1}$ sec.$^{-1}$, a value of the same order of magnitude as those obtained by Säverborn (*13*) on electrophoresis of polygalacturonic acids under comparable conditions. A sample was withdrawn from the final moving boundary and hydrolyzed. Quantitative paper chromatography indicated the presence of galacturonic acid and arabinose in a ratio of 9:1 but no galactose residues. The second component moved much slower than the first and the third was stationary. A sample taken at the starting boundary contained galacturonic acid, galactose, and arabinose in a ratio of 7:1:3. In boundary electrophoresis sampling is difficult, however, and the stationary peak could therefore have consisted of a salt boundary. The same three components were observed on electrophoresis in an acetate buffer at pH 3.8, although in this case the intermediate component was larger. In a phosphate buffer at pH 7.5, the pectic acid was resolved into two or possibly three mobile portions in addition to one stationary boundary.

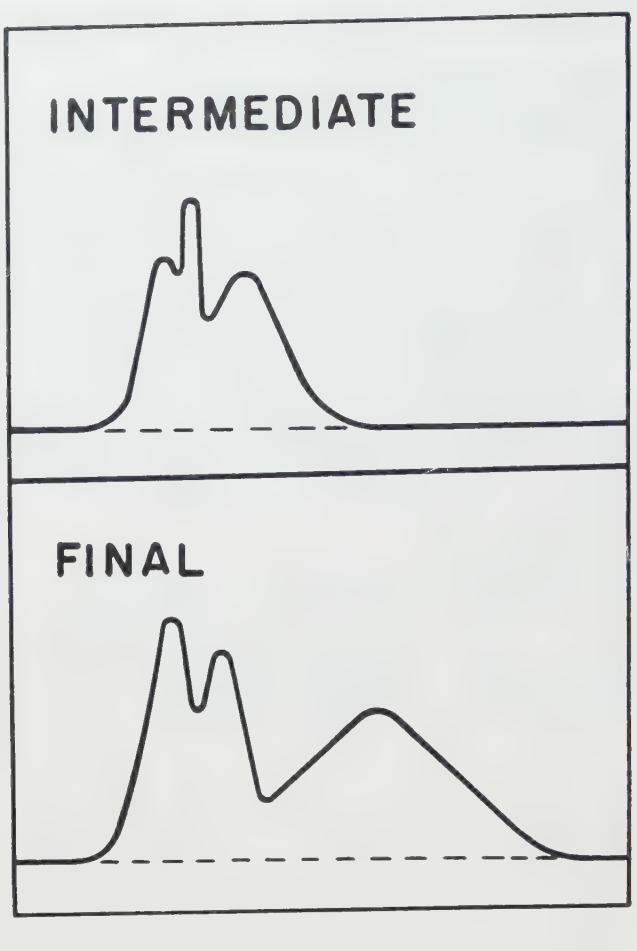


Fig. 2. Free boundary electrophoresis in sodium chloride solution

It can be tentatively concluded from these experiments that a predominating, negatively charged polysaccharide containing mostly galacturonic acid residues was present. Two additional polysaccharides capable of complexing with borate were also present. One of these evidently carried ionizable groups, probably in the form of galacturonic acid residues, but not to the same extent as the first polysaccharide. The third component could possibly be a neutral polysaccharide since it remained stationary except in the presence of borate.

DISCUSSION

The so-called "pectic triad," based on residues of D-galacturonic acid, D-galactose, and L-arabinose, is very widespread in nature (*14, 15*), where it occurs in practically all land plants and is one of the first carbohydrate products to be laid down in the primary wall on cell division. In wood the primary wall is especially rich in pectic material (*16, 17*), although the subsequent thickening of the secondary wall eventually renders the pectic content of mature wood rather insignificant. Larger quantities are present in the bark, approximately 3 to 4% in the present case, and 5 to 10% in normal softwood barks (*18*). The pectic triad is almost certainly a mixture of related polysaccharides, occurring together by virtue of their common biogenetic origin. Apparently there exists in higher plants a glycoside pool where the uridine diphosphate derivatives of D-glucose and D-galactose are readily transformed into each other. Enzymatic oxidation results in formation of the D-galacturonic acid derivative which is finally transformed into the L-arabinose compound by decarboxylation at C_6 (*19*). Thus, it has been found that in the formation of pectin in boysenberries (*20*) and strawberries (*21*), glucose is converted to galacturonic acid and arabinose with the chain of the first five carbon atoms in the hexose preserved intact.

Only rarely have definitely homogeneous polysaccharides other than polygalacturonic acids been isolated from the pectic triad. A reasonably pure β-(1 → 4)-linked galactan has been obtained from white lupine seeds (*22*) and a β-(1 → 5)-linked araban has been isolated from peanuts (*23*). Fractionation of a pectin from the leaves of the sisal plant (*11*) failed to produce a polygalacturonic acid devoid of rhamnose, galactose, and arabinose residues. On the basis of extensive methylation studies, it was suggested that these sugar residues were either linked to a polygalacturonic acid or originated from one or several polysaccharides containing both neutral and acidic sugar residues, in which case the majority of the galacturonic acid units would be derived from a pure polygalacturonic acid. A β-(1 → 4)-linked galactan with 10 to 25% galacturonic acid residues has recently been isolated from spruce compression wood (*24*). A similar polysaccharide is probably also present in birch wood (*25*). An araban recently isolated from sugar-beet pectin (*26*) contained appreciable quantities of D-galactose, L-arabinose, and galacturonic acid units. Only one peak was observed on electrophoresis, and it was therefore concluded that the material probably was homogeneous. The composition of this araban could not be changed by further fractionations. It should perhaps be noted, however, that failure to resolve a polysaccharide material by fractionation does not constitute an unequivocal proof of chemical uniformity (*27*).

The present results can only be regarded as preliminary and the final elucidation of the detailed structure of the pectic material in birch bark will have to await further experimental evidence. It appears certain that a polygalacturonic acid is present, composed of α-(1 → 4)-linked D-galacturonic acid residues. It is probable that this polyelectrolyte is of moderate molecular weight and that it is branched. Whether or not it contains minor quantities of sugar residues other than galacturonic acid is uncertain. Besides this major component, two additional polysaccharides are probably present. One of them possibly contains galactose and/or arabinose residues, but also galacturonic acid units, while the other might be a neutral polysaccharide. All, or at least most, of the arabinose residues occur as nonreducing end-groups in the furanose form. Since the galacturonic acid units were converted to galactose prior to the methylation, no information was available as to the mode of linkage of the original galactose residues in the pectic acid. The origin of the minor constituents, glucose, xylose, and rhamnose, is entirely unknown. A 4-*O*-(α-D-galactopyranosyluronic acid)-D-xylopyranose has been isolated from the wood of maritime pine (*28, 29*). 2-*O*-(α-D-galactopyranosyluronic acid)-L-rhamnopyranose has been obtained from many gums but also from a muci-

lage from slippery elm bark (*30*) and from the wood of maritime pine (*29*) and white pine (*31*).

The use of more efficient fractionation methods in conjunction with more thorough structural studies should furnish more information as to the exact nature of the pectic triad so ubiquitous in terrestrial plants. An attempt in this direction is presently being made with pectic material from the bark of various gymnosperms.

EXPERIMENTAL

All specific rotations are equilibrium values and were determined at 20°C. Melting points are corrected. Evaporations were carried out *in vacuo* at 50°C.

Paper Chromatography. Solvents (v./v.) used for separating sugars were (A) ethyl acetate-pyridine-water (8:2:1), (B) ethyl acetate-acetic acid-water (9:2:2), (C) butanone-water (89:11), and (D) *n*-butanol-ethanol-water (40:11:19). Electrophoresis was carried out with Whatman no. 3MM filter paper at 700 v. and in 0.05 *M* borate solution. *o*-Aminodiphenyl was used as a spray reagent and for quantitative sugar analysis (*32*).

Isolation and Attempted Fractionation of Pectic Material. Extractive-free inner bark from the autumn-felled tree was treated with hot water. The solid residue (10.3 kg.) was stirred with 0.5% ammonium oxalate in water at 70 to 80°C. for three days. The extract was recovered as described previously (*2, 3*) to yield an almost white powder (440 g., 4.2%) of ammonium pectate, containing galacturonic acid and arabinose residues in a ratio of 9:1, as well as a trace of galactose.

Addition of aqueous calcium chloride to the crude pectin (360 g.) caused precipitation of calcium pectate, which was exhaustively washed with water. After treatment with aqueous ammonium oxalate, calcium oxalate was removed by filtration over Celite. The remaining solution was dialyzed and concentrated. This process was repeated twice. After concentration, the final solution was poured into ethanol, and ammonium pectate was recovered in the usual way to give a white powder (56 g., 15.6%) with $[\alpha]_D$ + 240° (*c*, 1.4 in water). Qualitative paper chromatography (solvents A and B) indicated the presence of relatively more galactose and arabinose residues than in the original material. The same result was obtained on washing the free pectic acid or the copper salt with either water or dimethyl sulfoxide. Addition of cetyltrimethylammonium hydroxide or bromide (*8*) to an aqueous solution of the crude pectic yielded precipitates in low yield and of unchanged composition. A portion of the pectin was finally partially hydrolyzed with 0.01 and 0.02*N* H_2SO_4 for 2 to 24 hr. No preferential removal of arabinose- or galactose-yielding material was observed.

Crude pectic material was isolated in the same way from the spring-felled tree. A portion (200 g.) was dissolved in water and treated with Amberlite IR-120 exchange resin (acid form). After filtration, washing, and concentration, the solution was poured into four times its volume of ethanol. The precipitate was recovered by filtration, washed with 70% aqueous ethanol, ethanol, and petroleum ether (b.p. 30–60°C.) After drying *in vacuo* over phosphorus pentoxide a white, fluffy powder was obtained (120 g., 60%) with $[\alpha]_D$ +210° (*c*, 0.5 in water), uronic anhydride (*33*) 71.1%. methoxyl content 3.40%, and repeating equivalent weight (0.1*N* NaOH) 260, corresponding to a uronic anhydride content of 68%. Sugar residues in molar percentage were: galacturonic acid (66), galactose (7), arabinose (27), glucose, xylose, and rhamnose (traces). The infrared diagram of the product, determined by the potassium bromide pellet technique, contained a pronounced maximum at 1725 $cm.^{-1}$, indicative of the presence of carboxyl groups.

Identification of L-*Arabinose and* D-*Galacturonic Acid.* The mixture of neutral and acid sugars obtained from the second pectin was resolved on a column of Dowex 1-X4 exchange resin (acetate form). The neutral portion crystallized on standing and was recrystallized from aqueous methanol containing *n*-butanol to give L-arabinose, m.p. and mixed m.p. 155 to 156°C., $[\alpha]_D$ + 105° (*c*, 0.7 in water). The acid fraction contained only D-galacturonic acid, m.p. and mixed m.p. 157 to 158°C., $[\alpha]_D$ + 50° (*c*, 1.2 in water). The derived methyl (methyl α-D-galactopyranosyl) uronate had m.p. and mixed m.p. 148 to 149°C., $[\alpha]_D$ + 129° (*c*, 1.5 in water). Oxidation with nitric acid gave mucic acid, m.p. and mixed m.p. 212°C.

Esterification and Reduction of the Pectic Acid. Pectic acid (50 g.) was dissolved in water (500 ml.) and propylene oxide (200 ml.) was added (*10*). The solution was allowed to stand at 25°C. for 14 days, after which it was poured into acetone to give a precipitate which was recovered in the usual way. Yield of propylene glycol pectate was 58 g. A portion of the esterified pectic acid (50 g.) was dissolved in water (400 ml.) and an aqueous solution of sodium borohydride (50 g. in 400 ml.) was added dropwise over a period of 2 hr. The final pH of the solution was 11.5 and the temperature was 45°C. The same result was obtained when this reduction was carried out under more carefully controlled conditions (*34*). The solution was allowed to stand overnight and excess borohydride was destroyed by addition of acetic acid. After concentration to 500 ml., methanol (250 ml.) was added and evaporation was continued until the volume was 250 ml., when the same volume of methanol was added and then evaporated. This treatment was repeated twice more. The viscous, aqueous solution (250 ml.) was added with stirring to 3 liters of a 5:1 mixture of ethanol and acetone. The precipitate formed was washed and recovered in the usual way, dissolved in 500 ml. of water and treated with Amberlite IR-120 exchange resin (acid form). After filtration and concentration, the solution was again treated with propylene oxide as described above, and the ester was reduced. A total number of three such treatments were applied.

Small samples were withdrawn after each esterification-reduction cycle and titrated with standard alkali. The results indicated the presence of 18% uronic anhydride after the first reduction, 3.5% after the second, and 2.0% after the third. The final yield was 21 g. (52%) of a white powder, $[\alpha]_D$ + 154° (*c*, 1.0 in water). Examination by quantitative paper chromatography (solvents A and B) showed the presence of galactose, glucose, and arabinose residues in a ratio of 58:6:36, and also traces of galacturonic acid, xylose,

Table I. Fractionation of Methylated Sugars

Fraction no.	Test tubes no.	Composition of fraction	Weight, mg.	Mole, %
I	4–18	Mono-*O*-methylhexoses	29	1.4
II	30–57	Di-*O*-methylhexoses	117	5.2
III	60–92	Tri-*O*-methylgalactose	1176	48.6
IV	105–212	Mixture of sugars	236	10.1
V	216–239	Tetra-*O*-methylgalactose	70	2.8
VI	258–362	Tetra-*O*-methylgalactose (1 part) Tri-*O*-methylarabinose (10 parts)[a]	561	26.8
VII	363–500	Tri-*O*-methylarabinose	105	5.1

[a] This fraction also contained an additional 100 mg. of a methylated uronic acid which was removed by treatment with anion exchange resin.

and rhamnose. The infrared spectrum of the reduced polysaccharide had a small band at 1725 cm.$^{-1}$.

Methylation of the Reduced Pectic Acid. Reduced pectic acid (galactan) (14.0 g.) was dissolved in water (300 ml.) and sodium hydroxide (200 g.) was added with stirring in an atmosphere of nitrogen. Dimethyl sulfate (400 ml.) was added dropwise at 20°C. over a period of two days. After addition of sodium hydroxide (200 g.), dimethyl sulfate (350 ml.) was again added in the same way. The solution was adjusted to pH 4 with sulfuric acid and a little acetic acid. The reaction mixture (3 liters) was heated to boiling, when the partly methylated material separated on the surface as a sticky mass which could be easily lifted out. The product was washed briefly with hot water and dried *in vacuo* over phosphorus pentoxide to give 13.5 g. of material.

The partly methylated material was dissolved in dry dimethyl formamide (150 ml.) (*12*) and silver oxide (50 g.) and methyl iodide (50 ml.) were added. After shaking at 25°C. for two days, the same amounts of reagents and some Drierite were added. The mixture was shaken for another three days, chloroform (500 ml.) was added and solid material was removed by filtration. The solution was extracted once with 10% aqueous potassium cyanide, and then twice with water. After concentration to 40 ml., the yellow solution was added very slowly to three 400-ml. portions of petroleum ether in a Waring blendor. The precipitate was recovered by filtration, washed with petroleum ether, and dried *in vacuo* to give a white powder (9.0 g., 52%), $[\alpha]_D$ + 115° (*c*, 2.7 in chloroform); methoxyl content was 41.8%.

Resolution of the Hydrolyzate from the Methylated Product. The methylated product (9.0 g.) was subjected to methanolysis with 0.7*N* methanolic hydrogen chloride and subsequently hydrolyzed with *N* H_2SO_4 to yield 6.5 g. of a mixture of reducing sugars. A portion of the hydrolyzate (3.0 g.) was added to the top of a column (3.5 × 55 cm.) containing a 1:1 mixture of Darco G-60 charcoal and Celite. Gradient elution was carried out with 4 liters each of water → 20% aqueous ethanol and 20% ethanol → 40% ethanol. Fractions, 25 ml. each, were collected at a rate of two per hour. Every third fraction was examined by paper chromatography (solvent C). The results obtained are presented in Table I.

Characterization of Methylated Sugars. The mono- and di-*O*-methylhexoses were mixtures of several isomers as indicated by paper electrophoresis, and were not further studied. Demethylation with hydrobromic acid yielded galactose.

2,3,6-Tri-O-methyl-D-galactose. A portion (400 mg.) of fraction III, $[\alpha]_D$ + 90° (*c*, 3.2 in water), was converted to the corresponding aldonic acid by oxidation with bromine (*35*). After lactonization *in vacuo* at 60°C. for 2 hr., the 2,3,6-tri-*O*-methyl-D-galactonolactone (350 mg.) crystallized, m.p. 96 to 98°C. Recrystallization from ethyl ether gave needles with m.p. 100 to 101° and $[\alpha]_D$ − 30° (*c* 2.8 in water).

Anal. Calcd. for $C_9H_{18}O_6$:OMe, 41.9%. Found: OMe, 40.4%. Calcd. for $C_9H_{16}O_6$: OMe, 42.2%. Found: OMe, 42.0%.

Neither the tetra-*O*-methylgalactose nor its aniline derivative could be induced to crystallize, probably because of the presence of impurities. The rate of movement of the compound on the paper chromatogram was identical with that of an authentic sample of 2,3,4,6-tetra-*O*-methyl-D-galactose (solvents C and D). Demethylation gave galactose.

2,3,5-Tri-O-methyl-L-arabinose. A portion (50 mg.) of fraction VI, $[\alpha]_D$ −35° (*c*, 1.0 in water), was converted to the 2,3,5-tri-*O*-methyl-L-arabonamide (*36*), m.p. 130°C., $[\alpha]_D$ + 21° (*c*, 1.0 in ethanol) (*37*). Demethylation yielded arabinose.

Determination of the Molecular Weight of the Pectic Acid. Pectic acid (6.0 g.) was nitrated with a nondegrading nitric acid mixture (*38*) to give 6.0 g. of nitrate. Osmotic pressure measurements (*39*) were carried out with *n*-butyl acetate as the solvent and at 30°C. The value of $(h/w)_{w=0}$ was 0.76, corresponding to a molecular weight of 33,800 and an approximate number-average D.P. of 130. The methylated galactan in a 9:1 mixture of chloroform and ethanol gave $(h/w)_{w=0}$ = 0.95, corresponding to a molecular weight of 27,000 and a D.P. of 142.

Free Boundary Electrophoresis. Tiselius electrophoresis was carried out with a Spinco Model H apparatus. Photographs were taken at the initial, intermediate, and final stages, and for both the ascending and descending portions. The ionic strength was 0.1 throughout and the polysaccharide concentration was 2%. The total time of each experiment was 100 min. The results obtained with 0.05*M* borate and 0.1*N* NaCl solutions are presented in Figs. 1 and 2. Experiments were also carried out with acetate (pH 3.8) and phosphate (pH 7.5) buffer solutions (*40, 41*). In the sodium chloride solution the mobility of the most mobile component (probably the sodium salt of a polygalacturonic acid) was 11.3 × 10^{-5} cm.^{2} v.$^{-1}$ sec.$^{-1}$.

LITERATURE CITED

1. Jabbar Mian, A. and Timell, T. E., *Chem. and Ind.* 1552 (1959).
2. Jabbar Mian, A. and Timell, T. E., *Tappi* 43, No. 9: 775 (1960).
3. Jabbar Mian, A. and Timell, T. E., *Can. J. Chem.* 38: 1191 (1960).
4. Anderson, E. and Pigman, W. W., *Science* 105: 601 (1947).
5. Anderson, E., Wise, L. E., and Ratliff, E. K., *Tappi* 37, No. 10: 422 (1954).
6. Pigman, W. W., Anderson, E., and Leaf, R. L., *J. Am. Chem. Soc.* 70: 432 (1948).
7. Painter, T. J. and Purves, C. B., *Tappi* 43, No. 8: 729 (1960).
8. Bouveng, H. O. and Lindberg, B., *Acta Chem. Scand.* 12: 1977 (1958).
9. Whistler, R. L. and BeMiller, J. N., *Adv. Carbohydrate Chem.* 13: 289 (1958).
10. Deuel, H., *Helv. Chim. Acta* 30: 1523 (1947).
11. Aspinall, G. O. and Cañas-Rodriguez, A., *J. Chem. Soc.* 4020 (1958).
12. Kuhn, R., Trischmann, H., and Löw, I., *Angew. Chem.* 67: 32 (1955).

13. Säverborn, S., "A Contribution to the Knowledge of the Acid Polyuronides," Almqvist och Wiksells Boktryckeri A.B., Uppsala, 1945.
14. Hirst, E. L. and Jones, J. K. N., *Adv. Carbohydrate Chem.* 2: 235 (1946).
15. Whistler, R. L. and Smart, C. L., "Polysaccharide Chemistry," pp. 161–197, New York, Academic Press, Inc., 1953.
16. Meier, H., *Holzforsch.* 13: 177 (1959).
17. Sultze, R. F., Jr., *Tappi* 40, No. 12: 985 (1957).
18. Timell, T. E., unpublished results.
19. Neish, A. C., in Kratzl, K. and Billek, G., "Biochemistry of Wood," pp. 82–91, New York, Pergammon Press, 1959.
20. Seegmiller, C. G., Axelrod, B., and McCready, R. M., *J. Biol. Chem.* 217: 765 (1955).
21. Seegmiller, C. G., Jang, R., and Mann, W., *Arch. Biochem. Biophys.* 61: 422 (1956).
22. Hirst, E. L., Jones, J. K. N., and Walder, W. O., *J. Chem. Soc.* 1225 (1957).
23. Hirst, E. L. and Jones, J. K. N., *J. Chem. Soc.* 496 (1938).
24. Bouveng, H. O. and Meier, H., *Acta Chem. Scand.* 13: 1884 (1959).
25. Gillham, J. K. and Timell, T. E., *Svensk Papperstidn.* 61: 540 (1958).
26. Andrews, P., Hough, L., Powell, D. B., and Woods, B. M., *J. Chem. Soc.* 774 (1959).
27. Snyder, J. L. and Timell, T. E., *Svensk Papperstidn.* 58: 889 (1955).
28. Roudier, A. and Eberhard, L., *Tappi* 38: No. 9: 156A (1955).
29. Roudier, A. and Eberhard, L., *Bull. Soc. Chim. France* 2074 (1960).
30. Gill, R. E., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1469 (1939).
31. Banerjee, S. K. and Timell, T. E., *Tappi*, 43, No. 10: 849 (1960).
32. Timell, T. E., Glaudemans, C. P. J., and Currie, A. L., *Anal. Chem.* 28: 1916 (1956).
33. Browning, B. L., *Tappi* 32, No. 3: 119 (1949).
34. Wolfrom, M. L. and Juliano, B. O., *J. Am. Chem. Soc.* 82: 1673 (1960).
35. Pacsu, E., Trister, S. M., and Green, S. W., *J. Am. Chem. Soc.* 61: 2444 (1939).
36. Hirst, E. L. and Jones, J. K. N., *J. Chem. Soc.* 506 (1946).
37. White, E. V., *J. Am. Chem. Soc.* 68: 272 (1946).
38. Alexander, W. J. and Mitchell, R. L., *Anal. Chem.* 21: 1497 (1949).
39. Glaudemans, C. P. J. and Timell, T. E., *Svensk Papperstidn.* 61: 1 (1958).
40. Green, A. A., *J. Am. Chem. Soc.* 55: 2331 (1933).
41. Miller, G. L. and Golder, R. H., *Arch. Biochem.* 29: 420 (1950).

Received July 7, 1961.

The authors wish to express their gratitude to D. A. I. Goring and S. Harding for valuable assistance. Financial support from the National Research Council of Canada is gratefully acknowledged.

The Spectrophotometric Determination of Lignin in Small Wood Samples

DAVID B. JOHNSON, WAYNE E. MOORE, and LESTER C. ZANK

A method is described for the determination of lignin in wood samples in the milligram range. The sample, ground to pass an 80-mesh screen, is dissolved by treating it with acetyl bromide in acetic acid. Interfering substances are removed chemically, and the lignin content is computed from the absorbence of the resulting solution at 280 mμ. The measurements are reproducible, and an analysis can be completed in 1 hr. The absorptivities of lignins from 18 wood species are presented.

It is frequently desirable to determine the lignin content of very small wood samples, such as might be obtained from segments of growth rings or parts of cell walls, but no existing methods for lignin, except for the method of Bailey (*1*), have been adapted for application in the microrange. Spectrophotometry has been applied successfully to a great many similar analytical problems, but in the determination of lignin it has been used only on pulps, pulping liquors, and soluble fractions of lignin. The primary reasons for the lack of success in applying spectrophotometry to lignin in whole wood are: (1) that it is difficult to bring wood into solution without seriously degrading it, and (2) that satisfactory lignin preparations have not been available for use as spectrophotometric standards. The obvious advantages of ease, specificity, and sensitivity afforded by spectrophotometric methods, however, prompted an investigation of the problems associated with this particular application. A simple procedure requiring approximately 1 hr. has been developed at the Forest Products Laboratory by which: (1) wood can be brought into solution without apparent serious degradation, (2) precise measurements of the absorbence of the solutions can be obtained that can be related to lignin concentration, and (3) work can be done in the microsize sample range.

In brief, the method consists of treating an extractive-free sample of wood meal ground to a fineness passing an 80-mesh screen with a reagent of acetyl bromide in acetic acid. When dissolution is complete, excess reagent is removed by adding water, and bromine and polybromide are removed by adding hydroxylamine hydrochloride. The sample is diluted to volume with acetic acid, and the absorbance of the resulting solution is measured at 280 mμ. The lignin concentration is calculated from this absorbence and a previously established lignin absorptivity value, in accordance with the Beer-Lambert relationships.

$$c = \frac{\log \frac{I_0}{I}}{Kb} = \frac{a}{Kb} \qquad (1)$$

where

c = concentration in g.p.l.
I_0 = incident radiation
I = transmitted radiation
K = absorptivity
b = cell thickness, cm.
a = absorbence

The absorptivity of a particular lignin is calculated from the absorbence of a known standard lignin solution by again applying the Beer-Lambert relationships. The known lignin solution can be made up by acetyl bromide dissolution of weighed amounts of an isolated lignin, like "native" enzyme, or Bjorkman lignin, or by acetyl bromide dissolution of wood for which the lignin

David B. Johnson, Chemist, Wayne E. Moore, Chemist, and Lester C. Zank, Chemist, Forest Products Laboratory, Forest Service, U. S. Department of Agriculture. Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

content is known by virtue of some standard method.

EXPERIMENTAL

Apparatus. The reactor used was a glass-stoppered test tube made by the Kimble Glass Co. Its outside diameter is 19 mm., its length 150 mm., and its capacity 28 ml. Stoppers are notched to allow escape of expanding and evolved gases.

The constant temperature bath was regulated at 70 ± 0.1°C.

The spectrophotometer used was a Beckman Model DU equipped with 10-mm. silica cells.

Reagents. The reagents used were acetyl bromide, reagent grade, redistilled; 2 *M* NaOH; 7.5 *M* hydroxylamine hydrochloride, reagent grade, glacial acetic acid, reagent grade, redistilled; and 25% (by volume) acetyl bromide in acetic acid.

Samples. The wood samples used were ground in a micro Wiley mill to a fineness passing an 80-mesh screen, then extracted with an alcohol-benzene solvent in accordance with TAPPI Standard T 12 m-59. Their lignin content was measured by the 72% sulfuric acid method described in TAPPI Standard T 13 m-54. They were stored in controlled humidity containers until equilibrium was reached and the moisture content was then determined by vacuum-drying at 67°C., until constant weight was attained.

The spruce enzyme lignin was prepared according to the procedure described by Pew (*2*). The moisture content was determined by storing the lignin over magnesium perchlorate until no further loss in weight was noted. There was 8.3% residual carbohydrate in this material as measured by the methods of Saeman, Moore, Mitchell, and Millett (*3*), and lignin weights were corrected on this basis.

The spruce "native lignin" was prepared according to the procedure of Brauns (*4*). Its moisture content was calculated from its loss in weight while stored over barium oxide.

Procedure. To determine the absorptivity of a standard lignin, a sample having an accurately known weight, between 3.0 and 6.0 mg., is placed into a reaction tube. Ten milliliters of the 25% acetyl bromide reagent are added to the sample. The tube is stoppered with a notched stopper and then heated for 30 min. in a water bath maintained at 70 ± 0.1°C. The test tube is gently swirled at 10-min. intervals to mix reactants and promote dissolution. After 30 min. of heating, the sample is removed from the heating bath and placed in a beaker of water at 15°C. to cool. The cooled sample is transferred to a 200-ml. volumetric flask in which has been placed 9 ml. of 2 *M* NaOH and 50 ml. of acetic acid. A minimum amount of acetic acid is used as a washing solvent to complete the transfer. Then 1 ml. of 7.5 *M* hydroxylamine hydrochloride is added. The contents are mixed, cooled, and diluted to the desired volume with acetic acid. The absorbence of this solution at 280 mμ is measured, and the absorptivity of the lignin at this wavelength is calculated as follows from the amount added:

$$\text{Absorptivity (lignin)} = \frac{\text{Absorbence standard} - \text{Absorbence blank}}{\text{Concentration lignin (g.p.l.)}}$$

The blank is run along with the sample in the same manner.

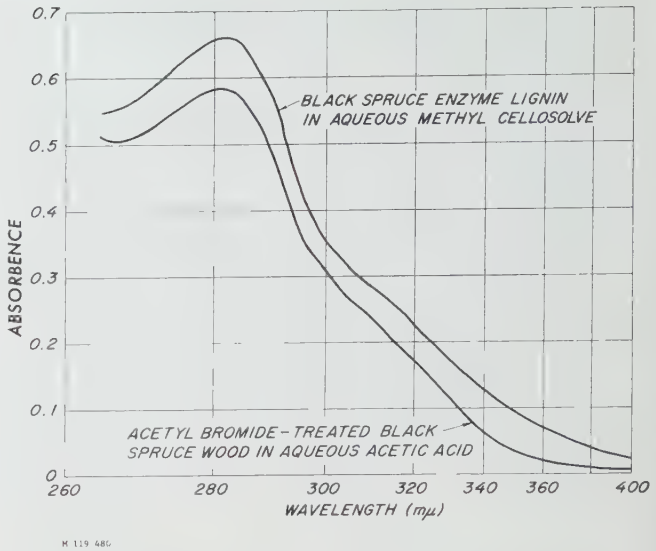


Fig. 1. Comparison of the ultraviolet spectra of solutions of enzyme lignin (0.035 g.p.l.) and wood solubilized by acetyl bromide treatment (0.025 g. lignin per liter)

To determine the lignin content of an unknown specimen, the same experimental procedure is followed, and the lignin content is computed as follows:

$$\text{Lignin } \% = \frac{(\text{Absorbence of sample} - \text{Absorbence of blank}) \text{ liters} \times 100}{\text{Absorptivity of lignin standard} \times \text{Sample weight (g.)}}$$

Samples containing more than 6 mg. of lignin are diluted with blank solution to give a concentration that has an absorbence between 0.3 and 0.7; if the sample contains less than 3 mg. of lignin, all volumes, including that of the acetyl bromide reagent, are reduced proportionally to give a satisfactory absorbence reading. If blanks are greater than 0.010 absorbence units, tests are repeated using freshly prepared reagents. Wood samples ranging from 2 to 101 mg. and containing from 0.6 to 21.3 mg. of lignin have been analyzed in this way at the Forest Products Laboratory. These weights, however, do not necessarily represent sample-size limits.

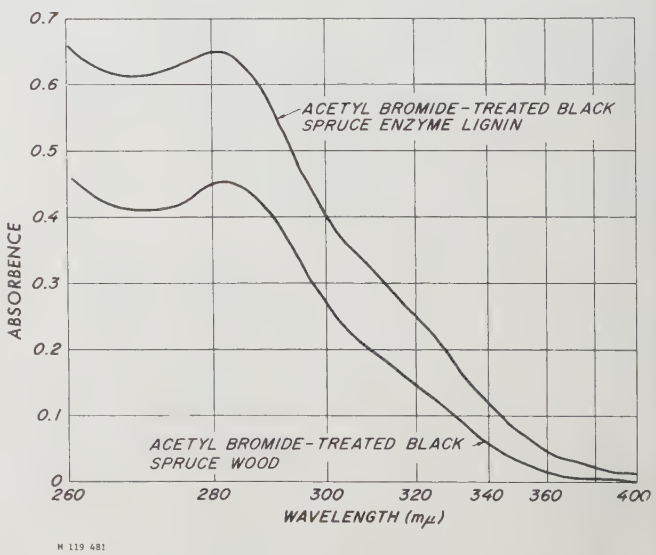


Fig. 2. Comparison of the ultraviolet spectra of isolated enzyme lignin (0.029 g. g.p.l.) and wood (0.020 g. lignin per liter) in 95% acetic acid after both were solubilized by acetyl bromide treatment

RESULTS AND DISCUSSION

Solubilization of Wood

Wood is almost wholly soluble in a reagent of 25% acetyl bromide, but a trace of material always remained insoluble in the experiments here reported.

This insoluble residue was identified as the membranous substances described by Pew (*5*), which originate as insoluble films deposited on the inner surfaces of ray cell parenchyma. This material, according to Pew, is found only in heartwood. In spruce it amounts to a mere trace but it makes up as much as 1% of the wood in Douglas-fir. After wood solutions are diluted to the required concentration for making absorbence measurements, the effect of undissolved particles is negligible.

Solutions of wood that have been treated with acetyl bromide are brown, but the color is not intense. A wood solution diluted to a concentration suitable for analysis (approximately 20 mg. of lignin per liter) is almost colorless. The ultraviolet absorption spectrum of wood treated with acetyl bromide is almost identical to those of treated and untreated enzyme lignin, as shown in Figs. 1 and 2. This suggests that (1) the basic lignin chromophore is relatively unaltered by treatment with acetyl bromide, and (2) the absorption in the ultraviolet of acetyl bromide–treated wood solutions is due to lignin, with little or none contributed by the nonlignin fraction. Negative aniline acetate tests for furfural support this second conclusion. Additional evidence was obtained by determining the absorptivity of the essentially nonlignin wood substance removed from spruce wood by cellulytic enzyme action. When approximately 60% of the wood substance was removed, the absorptivity of the material removed was found to be 0.29, using equation (2).

$$K = \frac{K_1 - K_2 f}{1 - f} \qquad (2)$$

where

K = absorptivity of the material removed by enzyme action
K_1 = absorptivity of original wood
K_2 = absorptivity of wood remaining after enzyme treatment
f = fraction of wood remaining after enzyme treatment (yield)

The true absorptivity of the nonlignin fraction is probably much smaller than the 0.29 for material removed by enzyme action, because the ultraviolet absorption curves of the enzyme liquors revealed that some lignin was removed in the enzyme treatment. An estimate of the amount of lignin lost indicated that it was enough to account for all of the loss in absorptivity of the residue. The absorptivity of the nonlignin fraction in spruce is then certainly not more than 0.29 (compared to more than 20 for lignin) at 280 mμ, and it is probably so much smaller as to be insignificant.

Some exploratory studies were also made on the reaction of wood pulps to acetyl bromide treatment. Results indicate that (1) pulps are difficult to dissolve in an acetyl bromide reagent, with a greater degree of pulp purification resulting in a greater amount of insoluble residue; and (2) ultraviolet spectra of highly purified pulps that have been treated with acetyl bromide exhibited no maxima from 400 to 250 mμ.

Hardwood (maple, oak, birch, aspen) products of the acetyl bromide procedure exhibit a marked difference from softwoods in their ultraviolet spectra, having no

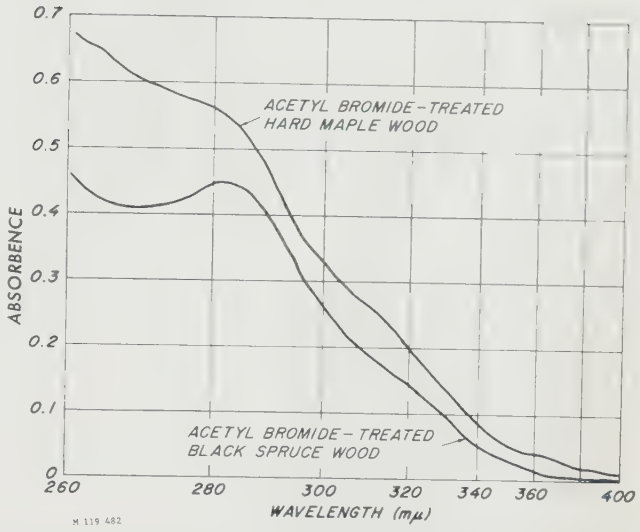


Fig. 3. Comparison of the ultraviolet spectra of a hardwood (0.024 g. lignin per liter) and a softwood (0.020 g. lignin per liter) in 95% acetic acid after both were solubilized by acetyl bromide treatment

trough in the 260- to 270- mμ region, as shown in Fig. 3. These spectra closely resemble the spectrum of aspen "native lignin" published by Buchanan (*6*) but differ from the spectra of "native" and enzyme lignins of oak, birch, and maple, published by Kudzin and Nord (*7*), which again have a trough in the 260- to 270- mμ region.

Figure 4 represents the change in absorptivity of a wood solution as the sample dissolves and during continued treatment with acetyl bromide. The absorptivity rises rapidly as the sample dissolves, and then the change in absorptivity with continued heating becomes quite small. Data plotted on Fig. 4 indicate that a 30-min. reaction time should be sufficient and that no advantage is to be gained from longer treatment. In fact, upon prolonged treatment (90 min.), an additional region of absorption appears near 315 mμ, as shown in Fig. 5. This additional absorption band is attributed to a carbohydrate derivative, since it does not appear in solutions of isolated lignin cooked for an equally long time. For this reason, initial reaction time in the solubilization step is kept as short as possible. There is no suggestion of this additional chromophore in the spectra

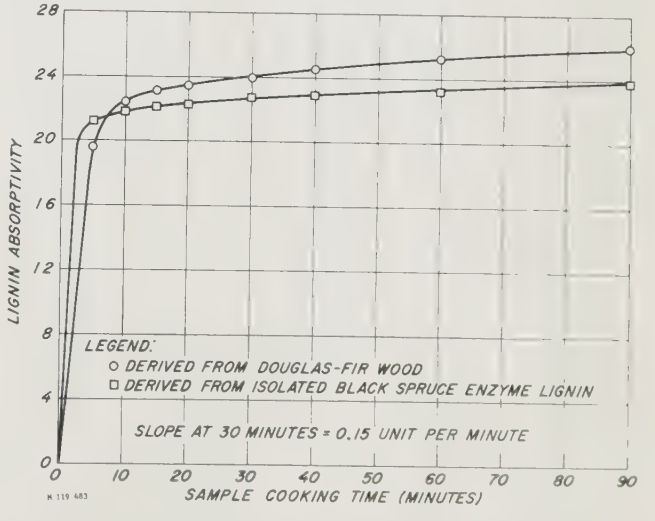


Fig. 4. Effect of duration of acetyl bromide treatment on the absorptivities of wood and isolated enzyme lignin at 280 mμ

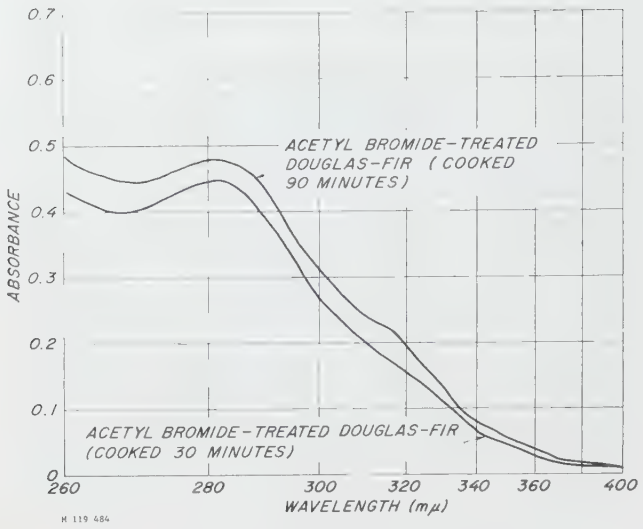


Fig. 5. Effect of prolonged acetyl bromide treatment on the ultraviolet spectrum of wood solutions. Concentrations were adjusted for easy comparison

of wood solutions treated for the specified time of 30 min., as shown on Fig. 5.

Test Precision

To get a statistical representation of the reproducibility or precision of the proposed test method, a series of samples of a softwood (Douglas-fir) and a hardwood (white oak) were dissolved, and their absorbencies were determined according to the procedures already outlined. The absorptivities were calculated on the basis of the lignin present as found by TAPPI Standard T 13 m-54 for lignin in wood, and the per cent values for lignin were computed from the average absorptivity.

$$\text{Absorptivity} = \frac{\text{Absorbence} \times \text{liters}}{\text{Grams wood} \times \text{fraction lignin (by TAPPI method)}}$$

The standard deviation was then computed in terms of lignin percentage values. Data and standard deviations are shown in Tables I and II. The data in these tables also show that solutions of acetyl bromide–solubilized lignins do not deviate significantly from Beer's Law in the milligram range.

Table I. Results of Replicate Spectrophotometric Lignin Determinations on Douglas-Fir Samples (Six Different Days)

Sample weight,[a] mg.	*Dilution, ml.*	*Absorbence*	*Absorptivity*	*Lignin, %*
8.752	200	0.300	24.02	28.58
23.913	200	0.814	23.85	28.38
51.623	1,000	0.354	24.03	28.60
73.316	1,000	0.503	24.04	28.61
12.490	200	0.427	23.96	28.51
5.451	100	0.373	23.97	28.52
2.109	100	0.144	23.92	28.46
2.430	100	0.168	24.22	28.82
4.289	100	0.296	24.18	28.70
4.423	100	0.304	24.09	28.67
5.596	100	0.382	23.92	28.46
6.584	100	0.452	24.06	28.63
3.565	100	0.245	24.09	28.67
6.324	100	0.434	24.04	28.61
11.284	100	0.773	24.01	28.57
10.172	200	0.346	23.84	28.37
16.492	200	0.562	23.88	28.42
19.922	200	0.676	23.78	28.30
12.594	200	0.430	23.93	28.48
11.496	200	0.393	23.96	28.51
Average			24.0	28.54
Standard deviation				0.13

[a] Extractive-free, moisture-free, and containing 28.54% lignin by TAPPI Standard T 13 m-54.

Table II. Results of Replicate Spectrophotometric Lignin Determinations on White Oak Samples (Five Different Days)

Sample weight,[a] mg.	*Dilution, ml.*	*Absorbence*	*Absorptivity*	*Lignin, %*
17.860	200	0.453	24.13	21.05
19.052	200	0.487	24.32	21.21
13.043	200	0.330	24.07	20.99
11.175	200	0.279	23.75	20.71
15.122	200	0.383	24.10	21.02
22.591	200	0.566	23.84	20.79
46.813	1,000	0.237	24.09	21.01
66.934	1,000	0.345	24.52	21.39
101.425	1,000	0.519	24.34	21.23
13.261	200	0.336	24.11	21.03
17.827	200	0.449	23.97	20.91
25.069	200	0.632	23.98	20.92
9.322	100	0.471	24.04	20.97
Average			24.1	21.02
Standard deviation				0.18

[a] Extractive-free, moisture-free, and containing 21.02% lignin by TAPPI Standard T 13 m-54.

No unusual degree of control is necessary in the test method in order to get the degree of precision shown in Tables I and II. The rate of change of absorptivity with respect to reaction time at the specified time of 30 min. is only 0.15 unit per minute, or less than 1% per minute, as shown on Fig. 4. The change of absorptivity with change of reaction temperature is approximately 1% per degree at 70°C. Both of these conditions are easily met, as are the requirements for reagent concentration, reagent volume, and hydroxylamine concentration and volume. Reasonable care must be exercised, however, since total water concentration has a crucial effect on absorbence properties.

The nature of the water-sample interactions is complex and not completely clear. The sodium acetate-water-acetic acid mixture into which the sample is first transferred converts excess acetyl bromide to acetic acid and sodium bromide, and it also converts labile products into more stable forms, resulting in a more uniform product. The time elapsing between the transfer step and final dilution with acetic acid must be standardized and kept short (5 min. or less), however, because some change in sample properties continues to take place in the water-rich mixture. The continuing change is at a slow rate, but can nevertheless result in a significant decrease in absorptivity. Dilution to volume with acetic acid arrests further change and stabilizes the solution. For the same reason, sample tubes are left in the 15°C. bath until they can be completely transferred and diluted to the desired volume. Samples are optically stable in the cooling bath and, similarly, they are optically stable after dilution with acetic acid. After dilution, solutions of Douglas-fir wood showed no change in absorbence for as long as 5 hr. Hardwood solutions are somewhat less stable, and their absorbence should be read within 1 hr. after they have been transferred.

The purpose of the hydroxylamine hydrochloride is to remove bromine and polybromide formed during the reaction. Bromine itself is only a weak absorber at 280 mμ; but the polybromide ion, which forms readily when bromine and bromide are mixed (*8*, *9*), is a very strong absorber at 280 mμ with an absorption maximum in 95% acetic acid at 267.4 mμ (Fig. 6). Popov

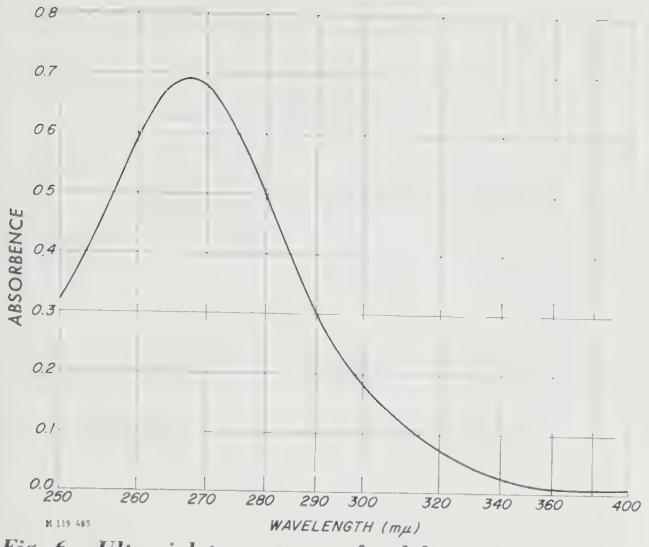


Fig. 6. Ultraviolet spectrum of polybromide ion in 95% acetic acid

and Skelly (*10*) report a molar absorptivity of 55,000 at 269 mμ in acetonitrile for the polybromide ion.

Absorptivity Values

The data given in Tables I and II were derived from absorptivities based on the TAPPI method for determining lignin in wood. But other methods or direct spectrophotometric lignin standards, such as Brauns' "native lignin" (*4*), enzyme lignin (*2*), or Bjorkman lignin (*11*), can also be used; the standard selected depends on the application.

The absorptivity values of the lignins in 18 wood species were determined and listed in Tables III and IV. Calculations were made as already outlined, and the assumed true lignin content of the standard samples was obtained using TAPPI Standard T 13 m-54.

A significant feature of the absorptivities reported in Tables III and IV is their relative uniformity which, for all 18 wood species, ranges ±4.5% from the average. This tends to strengthen data where an absorptivity derived from a standard wood sample would be used to calculate lignin in a different but related sample as, for instance, a sample representing only certain portions of cells that might be high or low in lignin, or one of reaction wood or bark containing lignin that might be slightly different chemically, or a small sample from another wood species for which no absorptivity value is accessible.

In direct gravimetric methods for lignin where the nonlignin material is removed from the sample by acid hydrolysis, some of the lignin is lost as an acid-soluble fraction (*2*, *12–19*), resulting in low values. One of the potential advantages of a spectrophotometric method is that this problem of acid-soluble lignin may be eliminated, since the entire sample is dissolved and no phase separation is necessary. The realization of this advantage depends, of course, on having a satisfactory absolute lignin standard from which to get an absolute

Table III. Absorptivities of Lignins from Various Softwoods

Wood	*TAPPI lignin, %*	*Weight sample, mg.*	*Absorbence at 280 mμ*	*Dilution, ml.*	*Absorptivity*	*Average absorptivity*
Douglas-fir	28.54	8.752	0.300	200	24.02	
		23.913	0.814	200	23.85	
		51.623	0.354	1,000	24.03	
		73.316	0.503	1,000	24.04	24.0
Loblolly pine	27.12	11.451	0.367	200	23.63	
		11.860	0.381	200	23.69	
		14.645	0.472	200	23.63	23.7
Black spruce	26.78	9.176	0.287	200	23.36	
		8.191	0.258	200	23.52	
		9.188	0.291	200	23.65	23.5
Western larch	27.76	11.716	0.381	200	23.43	
		11.618	0.376	200	23.32	
		11.688	0.379	200	23.36	23.4
White spruce	26.32	11.308	0.347	200	23.32	
		10.121	0.314	200	23.57	
		11.917	0.367	200	23.40	23.4
White fir	28.78	10.060	0.335	200	23.14	
		10.275	0.343	200	23.20	
		11.712	0.372	200	23.14	23.2
Western red cedar	32.64	9.158	0.345	200	23.08	
		8.704	0.328	200	23.09	
		9.099	0.342	200	23.03	23.1
White pine	29.29	13.482	0.455	200	23.04	
		10.335	0.345	200	22.79	
		10.187	0.343	200	22.99	22.9
Hemlock	28.90	12.263	0.403	200	22.74	
		9.392	0.305	200	22.48	
		8.615	0.280	200	22.49	22.6
Average softwood absorptivity						23.3

Table IV. Absorptivities of Lignins from Various Hardwoods

Wood	*TAPPI lignin, %*	*Weight sample, mg.*	*Absorbence at 280 mμ*	*Dilution, ml.*	*Absorptivity*	*Average absorptivity*
Aspen	18.15	11.630	0.260	200	24.63	
		12.494	0.276	200	24.34	
		13.111	0.291	200	24.45	24.5
White ash	21.70	13.990	0.370	200	24.37	
		15.644	0.419	200	24.68	
		15.391	0.407	200	24.37	24.5
White oak	21.02	17.860	0.453	200	24.13	
		19 052	0.487	200	24.32	
		13.043	0.330	200	24.07	
		11.175	0.279	200	23.75	24.1
Yellow birch	22.39	14.072	0.365	200	23.17	
		15.992	0.427	200	23.85	
		15.710	0.415	200	23.60	
		16.172	0.423	200	23.36	23.7
Hard maple	22.60	10.844	0.285	200	23.26	
		14.635	0.390	200	23.58	
		7.144	0.188	200	23.28	
		24 019	0.644	200	23.73	
		51.541	0.277	1,000	23.78	
		81.062	0.437	1,000	23.68	23.6
Southern red oak	23.31	13.469	0.366	200	23.31	
		15.332	0.420	200	23.50	
		18.087	0.491	200	23.29	23.4
Black cotton-wood	22.89	8.614	0.230	200	23.33	
		10.770	0.286	200	23.20	
		10.627	0.281	200	23.10	23.2
Basswood	18.53	10.714	0.228	200	22.97	
		10.589	0.225	200	22.94	
		10.010	0.210	200	22.64	22.9
Sweetgum	26.58	16.373	0.486	200	22.33	
		16.932	0.504	200	22.40	
		18.467	0.552	200	22.49	22.4
Average hardwood absorptivity						23.6

Table V. Summary of Absorptivities of Various Spruce Lignin Preparations

Sample	*Chemical solubilization treatment*	*Absorptivities: Based on weighed amount*	*Absorptivities: Based on TAPPI method*	*Summary*
Black sprucewood	Acetyl bromide		23.5[a]	23.5
Spruce enzyme lignin (28.0% yield)	Acetyl bromide	22.5[b]		22.5
Spruce "native lignin"	Acetyl bromide	20.9		20.9
Spruce "native lignin"	None	19.5[c]		19.5
Spruce enzyme lignin (28.0% yield)	None	19.1[b,c]		19.1

[a] From Table III.
[b] Corrected for carbohydrate by the method in reference (*3*).
[c] From reference (*2*).

absorptivity. In a recent paper, Pearl and Busche (*19*) estimated acid-soluble lignin concentrations in hydrolyzate filtrates spectrophotometrically, using an absorptivity based on the absorption of solutions of weighed amounts of Bjorkman milled-wood lignin. Although they could not be certain that the absorptivity used corresponded exactly to that of protolignin, they did consider it satisfactory.

Absorptivities of various spruce lignin preparations are summarized in Table V.

CONCLUSIONS

A procedure has been developed by which whole wood can be brought into solution with very little alteration in the ultraviolet spectrum of the lignin. The absorbence of the resulting solution at 280 mμ is proportional to the amount of lignin present and is the basis for a precise, quantitative method of analysis. As an indirect method, using absorptivities based on a standard test, the method offers the advantages of being rapid, easy, and applicable in the microrange. As a direct method, using absorptivity values based on standard lignin preparations, it has the additional advantages of diminishing interference from nonlignin products and eliminating the acid-soluble lignin problem.

LITERATURE CITED

1. Bailey, A. J., *Mikrochemie* 19, 98 (1936).
2. Pew, J. C., *Tappi* 40, 553 (1957).
3. Saeman, J. F., Moore, W. E., Mitchell, R. L., and Millett, M. A., *Tappi* 37, 336 (1954).
4. Brauns, F. E., *J. Am. Chem. Soc.* 61, 2120 (1939).
5. Pew, J. C., *J. Forestry* 47, 196 (1949).
6. Buchanan, M. A., Brauns, F. E., and Leaf, R. L., *J. Am. Chem. Soc.* 71, 1297 (1949).
7. Kudzin, S. F. and Nord, F. F., *J. Am. Chem. Soc.* 73, 4619 (1951).
8. Ray, S. K., *J. Ind. Chem. Soc.* 9, 259 (1932).
9. Ray, S. K., *J. Ind. Chem. Soc.* 10, 213 (1933).
10. Popov, I. and Skelly, N. E., *J. Am. Chem. Soc.* 77, 3724 (1955).
11. Bjorkman, A. *Svensk Papperstidn.* 59, 477 (1956).
12. Campbell, W. G. and McDonald, I. R. C., *J. Chem. Soc.* 3180–3183 (1952).
13. Pearl, I. A., *For. Prod. J.* 7, 88 (1957).
14. McDonald, I. R. C., *J. Chem. Soc.* 3183–3186 (1952).
15. Browning, R. L. and Bublitz, L. O., *Tappi* 36, 452 (1953).
16. Richtzenhain, H. and Dryselius, E., *Svensk Papperstidn.* 56, 324 (1953).
17. Pearl, I. A. and Beyer, D. L., *Tappi* 40, 45 (1957).
18. Marth, D. E., *Tappi* 42, 301 (1959).
19. Pearl, I. A. and Busche, L. R., *Tappi* 43, 961 (1960).

RECEIVED June 22, 1961.

The Process of Fiber Separation

III. Hydrolytic Degradation Within Living Trees and Its Effects on the Mechanical Pulping and Other Properties of Wood

C. M. STEWART, J. F. KOTTEK, H. E. DADSWELL, and A. J. WATSON

Microtome sections of wood from eucalypts and from *Pinus radiata* have been subjected to various chemical treatments, the changes produced being observed by staining reactions and by differences in the ease of mechanical defibration. The results support the hypothesis that acid hydrolysis occurs within living trees, the main acid involved being acetic acid produced chiefly by hydrolysis of the *O*-acetyl groups which are associated with the noncellulosic polysaccharides of wood. The changes in behavior of the double stain, safranin, and light green, have been shown to be related to the extent of hydrolytic degradation of wood rather than to changes in the relative proportions of lignin and cellulose within the wood. In general the changes produced during the hydrolysis *in situ* are such that fibers separate more readily under the influence of mechanical forces; *i.e.*, the older the wood the greater is the ease of fiber separation. The observations agree with the finding that, in general, old trees of *Eucalyptus regnans* yield better groundwood pulps than young trees. The experiments demonstrate that wood from young trees may be rendered equivalent to or better than that from old trees in ease of mechanical defibration. Alkali solutions are of the order of 10^3 times as effective as acid solutions, of equivalent ionic concentration, for increasing the ease of fiber separation; in this respect, hot dilute alkali solutions (0.05% at 98°C.) are more effective than cold, more concentrated alkali solutions (5% at 20°C.). Delignification (two cycles) by the chlorite holocellulose method is not much more effective in increasing the ease of fiber separation than treatment with hot dilute alkali; two delignification cycles are little more effective than one cycle. If an alkali treatment is applied after partial delignification and before mechanical defibration, then two delignification cycles are much more effective than one cycle; the energy consumed during the defibration of material from one delignification cycle is more than three times that required for the material from two cycles of delignification. Evidence is advanced in support of the contention that the process of fiber separation is controlled mainly by the scission of covalent interfiber bonds. Alkali-sensitive bonds, apparently ester bonds, existing between lignin and the uronic acid units of the noncellulosic polysaccharides seem to play a predominant role in interfiber cohesion. However, evidence is advanced for the existence of other interfiber bonds which are resistant toward alkali but labile in the presence of acid; thus consecutive pretreatments with acid and alkali are much more effective for inducing fiber separation than a single pretreatment with either acid or alkali. The occurrence of brittle heart in the centers of old trees has been correlated with the extent of hydrolytic degradation which has taken place within the living trees.

C. M. STEWART, Principal Research Officer; Mrs. J. F. KOTTEK, formerly Research Officer (now 9 Clyde Street, West Newport, Victoria); H. E. DADSWELL, Chief of Division; and A. J. WATSON, Senior Research Officer, Division of Forest Products, C.S.I.R.O., 69 Yarra Bank Road, South Melbourne, Victoria, Australia.

THE BEHAVIOR of radial sections of wood when subjected to chemical and mechanical treatments has been reported in Part I of this series (*1*). Alkali pretreatments were much more effective than acid pre-

treatments for increasing the ease of mechanical defibration. After removal of more than 70% of the lignin, the effect of alkali pretreatment was especially marked and the rate of fiber separation appeared to be controlled chiefly by the scission of interfiber, covalent chemical linkages. Hence, evidence concerning the existence and nature of such linkages is of importance to the study of fiber separation.

Jaeger and Somerville (*2*) and Somerville and Burkitt (*3*) have observed that mechanical pulps prepared from the wood of *Eucalyptus regnans* F. Muell. vary greatly from one sample to another; the variation is large both between and within trees and seems to be related to the age of the trees. These findings suggest that there exists at least one inherent property of wood which is subject to variation with time; one such property would be the degree of bonding between fibers. It has been shown (*1*) that hydrolysis with hydrogen or hydroxyl ions influences this property.

The question immediately arises: can hydrolysis occur within the living tree? The fluids expressed from *E. regnans* woods are acidic, their pH varying from values less than 2 to 6. Bland, *et al.*, have shown (*4*) that the airdry wood of *E. regnans* contains appreciable quantities of acetyl groups; hydrolysis of acetyl groups may be expected to produce acetic acid, the quantity produced depending upon the time of hydrolysis; *i.e.*, upon the age of the wood. Acids other than acetic acid must also be present in the expressed fluids because the degree of dissociation of acetic acid, for reasonable concentrations *in situ*, is not great enough to produce pH values below 2. The above factors suggest that hydrolytic degradation may occur within living trees; experiments carried out *in vitro* may be used to validate the above suggestion.

Stewart, *et al.*, have shown (*5*, *6*, *7*) that when *E. regnans* wood is heated in mildly acidic methanol, the nonresistant polysaccharides are readily rendered soluble, or potentially soluble, in water; when the extracted residues are delignified according to the holocellulose procedure the polysaccharides rendered potentially soluble dissolve in the aqueous reagents used for the preparation of holocellulose. These and other observations have been taken as indirect evidence for the existence of chemically bonded complexes involving lignin and the nonresistant polysaccharides, these components possibly being linked together by uronic acid ester bonds. Such bonds would be labile in the presence of both acids and alkalies, especially in the presence of the latter reagents. If the bonds are concerned with interfiber cohesion, their scission would decrease the extent of bonding between fibers.

Somerville and Burkitt (*3*) have shown that *E. regnans* wood from *ca.* 370-yr.-old trees ground more readily, during groundwood pulp production, and gave stronger pulps than wood from 23-yr.-old trees of the same species. Watson and Cohen (*8*) analyzed these woods and demonstrated that the pentosan contents of woods from young and old trees were similar, but the yields of holocelluloses and the pentosan contents of the holocelluloses were, respectively, 8 and 5% (o.w.b.) lower in the old trees than in the young trees. Thus, using the analogy of wood treated with mildly acidic methanol (*5*), it is probable that during holocellulose preparation the woods from the old trees lost a considerable portion of their nonresistant polysaccharides, which were rendered potentially soluble in water as a result of acid hydrolysis within the living tree.

In order to test further the hypothesis of hydrolysis within living trees it was decided to examine microtome sections removed from various positions along "radii" of several trees and to determine the chemical and mechanical properties of the different sections both before and after treatments with hydrolyzing reagents.

In addition to these experiments it was deemed advisable to obtain comparative indications of changes which may occur in the wood during chemical treatments; such indications may be aided by the use of the following stains: (i) safranin O and light-green SF yellowish, and (ii) ruthenium red.

Stain (i) has been used to estimate the degree of lignification of plant tissues (*9*, *10*, *11*). The safranin component is regarded as a lignin stain, whereas the light-green SF yellowish (or fast-green FCF) is considered to be a stain for cellulose. Although it is realized that this staining combination does not necessarily yield reliable information on the chemical composition of the wood, it was considered that the results of comparative tests, during chemical reactions in wood, may give information of some value.

Clarke (*11*) has shown that sections of woods, especially those of temperate climatic regions, lose their red-staining potentialities and tend to become green-staining after boiling in water for several hours. Dadswell and Ellis (*12*) have demonstrated, during progressive delignification cycles according to the holocellulose method, that there is a good correlation between the amount of lignin in the secondary cell wall and its affinity for safranin. Harlow (*13*) has shown that transverse sections of some woods stain red while others stain either red and green or entirely green with stain (i); however, when the sections were treated with 0.12% aqueous solutions of sodium hydroxide, before staining with (i), the sections from all of the woods tested stained entirely green. The green-staining of secondary walls has been used for indicating the presence of tension wood in hardwoods; see, for example, Wardrop and Dadswell (*14*).

Ruthenium red, stain (ii), is generally reputed to be suitable for determining the presence of carboxyl groups in polyuronides (*15*) and in other substances containing uronic acid units (*16*). In general it stains the intercellular layer and primary cell wall more intensely than the secondary cell wall. Wardrop (*17*) has shown, in the case of the developing xylem of *E. regnans*, that the intensity of staining decreases as the degree of lignification increases.

RESULTS AND DISCUSSION

Staining Experiments

Transverse sections removed from different positions along radii of tree cross-sectional strips of wood were used in the untreated condition and after certain standard treatments with chemical reagents.

Untreated Wood. All sections from young wood (<50 yr.*) stained red with safranin–light green, except

* For the purposes of this discussion the age of wood is the time, in years (as determined by counting growth rings from the cambium), which has elapsed between the formation of the wood and the felling of the tree.

Fig. 1. The positions, in the two trees of E. gigantea, *from which small blocks of wood were removed*

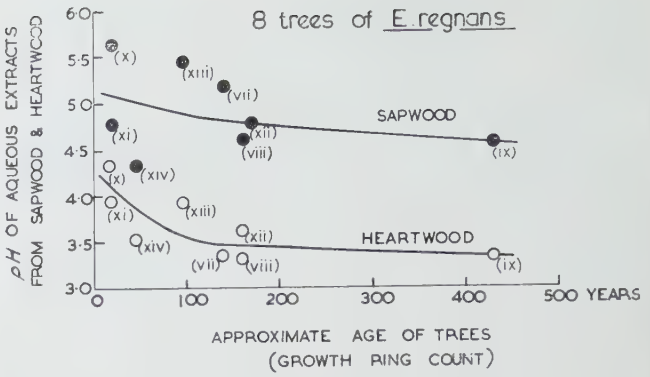


Fig. 2. The variation with age of wood of mean pH values of extracts of wood as determined in eight trees of E. regnans

for traces of green staining which sometimes occurred in the secondary walls of some fiber cells, especially those of early wood. Little or no staining was observed with ruthenium red; where it did occur the intensity increased slightly with age of wood; *i.e.*, toward the center of a tree.

Sections from older woods (>50<430 yr.) showed a progressive decrease in red-staining and a parallel increase in green-staining as a radius was traversed from the outside toward the center of a tree, using the double stain safranin–light green. For example, in the case of tree (*ix*) the staining reactions were as follows: 0 to 160 yr., sections stained red; 160 to 300 yr., red-staining in the late wood and green-staining in early wood; 300 to 420 yr., sections stained green. In all sections (0 to 420 yr.) the intensities of staining varied with age of wood in the manner indicated above, except that the decrease in safranin staining was not noticeable in young wood.

Staining with ruthenium red was such that the intensity increased in a progressive manner with increases in the age of wood.

Hydrolyzed Wood. The transverse sections were hydrolyzed with dilute solutions of alkali and acid; for comparative purposes identical conditions were used for any set of sections from a particular tree radius.

In general mild hydrolytic treatments enhanced the degree of staining differentiation and, in most cases, sections from trees whose xylary tissues stained entirely red with safranin–light green developed green-staining properties, the extent of ultimate green-staining increasing with increases in the age of wood.

The initial young *E. regnans* wood [*e.g.*, tree (*i*)] showed red staining of the intercellular layer and of the primary and secondary fiber cell walls, with traces of green-staining in the secondary walls of some fibers. As the time of hydrolysis was increased the areas giving green-staining became more extensive, the green-staining gradually progressing from the inner layers of the secondary wall, through the secondary and then primary walls to the intercellular layer. The intercellular materials, situated at the corners of cells, seemed to retain their safranin-staining potentialities for the longest periods of time. This observation is of interest when considered in conjunction with Abrams' observation (*18*) that these materials remained insoluble for the greatest period of time during soda pulping. Wardrop (*19*) has noted recently that pulping liquors, when forced to percolate through solid blocks of hardwood, tend to travel rapidly through the vessels; then, more slowly, they gain access to the cell lumen through pits and finally they diffuse outwards through the cell wall; thus the material located between the corners of adjacent cells will be reached last by the diffusing pulping liquors. A similar diffusion control of the movement of the hydrolytic reagents through the fiber cell wall could account for the observed staining results.

After prolonged periods of hydrolysis with 0.05% solutions of sodium hydroxide at 70°C. the whole cross-section stained green.

In general those portions of the cell wall, in which safranin-staining persisted for the greatest period of time during hydrolysis, eventually gave the highest intensity of green-staining. Again, the late wood always retained its red-staining potentialities for greater periods than the early wood.

More concentrated (5%) solutions of sodium hydroxide at 23°C. caused changes similar to those produced by the hot, dilute alkali solutions. It was observed, also, that dilute solutions of strong acids (0.05 and 6% HCl) brought about analogous changes in the staining behavior of wood; in general acid hydrolysis must be much more drastic than alkali hydrolysis for the same degree of staining behavior.

The sections of *Eucalyptus nitens* Maid. wood [tree (*iii*)], *Pinus radiata* D. "normal" and compression woods [tree (*vi*)], *Eucalyptus gigantea* Hook f. [trees (*iv*) and (*v*)], and *Eucalyptus diversicolor* F. Muell. [tree (*xvii*)] woods behaved, during hydrolysis, in a manner similar to that of *E. regnans* woods. The compression wood of *P. radiata* required a greater period of hydrolysis than the "normal" wood to reach the same degree of green-staining, as judged by visual examination.

All samples of old wood appeared to have undergone hydrolysis while within the living tree, the extent of hydrolysis being more or less directly proportional to the age of the wood.

Results, similar to those described above for safranin–light green staining, were obtained when the hydrolyzed sections were treated with ruthenium red; *i.e.*, increasing times of hydrolysis caused increasing intensities of staining, particularly in the region of the intercellular layer and the primary cell wall. Because ruthenium red is a stain reputedly specific to carboxyl groups in mature wood, the observations indicate that the concentration of free carboxyl groups increases during hydrolytic reactions. Therefore it may be

Table I. Staining Behavior with Safranin and Light-Green

l.w. = late wood; e.w. = early wood

Treatment	Sapwood	Heartwood				
	Age of wood, yr.					
	0–15	30–45	75–115	150–160	200–230	320–420
Untreated	Red	Red	Red	Red	Red in l.w. Green in e.w.	Green
Untreated plus treatment with 0.05% NaOH	Red	Mainly red	Red in l.w. Green in e.w.	Red in l.w. Green in e.w.	Green	Green
1 cycle of delignification	Red	Red	Mainly red	Red and green	Red in l.w. Green in e.w.	Green
2 cycles of delignification	Red	Mainly red	Trace of red in l.w.	Green	Green	Green
3 cycles of delignification	Trace of red in l.w.	Green	Green	Green	Green	Green

assumed that, in mature young wood, the carboxyl groups are chemically bonded to other wood components and that during hydrolysis either *in situ* or *in vitro*, the bonds suffer scission to liberate free carboxyl groups.

Treatment of eucalypt sections with cold 5%, as compared with hot 0.05% solutions of sodium hydroxide, caused, after an initial increase, a reduction in the intensity of staining with ruthenium red. The reduced intensity of staining may be attributed to the dissolution of polysaccharides rich in uronic acid units (*7*).

It was found, by comparing the intensities of green-staining, that the amount of acid hydrolysis apparent in wood approximately 160 yr. old [*E. gigantea*, tree (*v*)] was equivalent to that caused by hydrolyzing sections of sapwood with 0.05% sodium hydroxide solution at 70°C. for 5 to 10 min. For purposes of calculation it may be assumed that 5- to 10-min. hydrolysis with dilute alkali solution is equivalent to 160 yr. hydrolysis with acid at pH 3.5 (the mean pH of the heartwood extracts) at a temperature of 8° C. (see Experimental). pH values of 3.5 and 10.5 represent equivalent concentrations of hydrogen and hydroxyl ions; the latter pH value is equivalent to a hydroxyl ion centration of *ca.* 3.16×10^{-4}. Thus hydrolysis at pH 10.5 would take about 40 times as long for equivalent effect as hydrolysis with 0.05% (*i.e.*, 1.25×10^{-2}) alkali, assuming that the degree of dissociation is unity. Using the $Q_{10°}$ value of 2.4 found in earlier work (*1*), the hydrolysis at 8°C. would take about 200 times as long for equivalent effect as hydrolysis at 70°C. Hence the ratio of times of hydrolysis in acid and alkali of equivalent ionic concentration is approximately:

$$\frac{160 \cdot 365 \cdot 24 \cdot 60}{(5 \text{ to } 10)40 \cdot 200} = 1000 \text{ to } 2000$$

This calculation suggests that alkalies (hydroxyl ions) are of the order of 10^3 times as effective as acids (hydrogen ions) in causing changes in the staining behavior of eucalypt woods.

Partial Delignification of Wood. Transverse sections removed from trees (*vii*) to (*xiii*) of *E. regnans* were subjected to increasing numbers (1 to 3) of delignification cycles. In general, with safranin–light green, the treated sections changed from red-staining to green-staining as the number of delignification cycles was increased.

Superimposed on this general pattern of staining there was a differential staining behavior for any particular tree; *i.e.*, the older the wood the greater was its tendency to stain green. The results obtained for tree (*ix*) are listed in Table I.

It will be noted that a mild treatment with dilute alkali solution, which removes very little lignin (*20*), is more efficacious in causing changes in staining behavior than one cycle of delignification which removes about half of the lignin initially present in wood.

The intensity of staining with ruthenium red was high for all 2- and 3-hr. delignification treatments; in the case of 1-hr. treatments the intensity of staining increased with the age of the wood.

The results, in general, suggest that the staining behavior of safranin and light green is modified by hydrolysis either *in situ* or *in vitro* and, if old wood is being examined, green-staining does not indicate, necessarily, that the wood contains little lignin.

Acids in Wood

Acyl groups appear to occur in all woods. Schwalbe and Becker (*21*), Schorger (*22*), Mahood and Cable (*23*), and Ritter and Fleck (*24*) have analyzed many species of wood and have shown that, in general, softwoods contain up to 2% and hardwoods from 2 to 6% of acyl groups, expressed as acetic acid. The content of acyl groups in heartwood is generally appreciably lower than that in sapwood (*24*).

Timell (*25*) has shown that formyl groups may represent as much as 3% of the total acyl groups. It is generally assumed that acetyl groups represent most of the acyl groups.

Tang (*26*) has demonstrated that all the acyl groups appear to be present in the "skeletal substance" of wood and Stewart, *et al.*, have obtained evidence (*7*) which suggests that most of the acyl groups are associated with the nonresistant polysaccharides in the wood of *E. regnans* and that more than half of these groups may be removed by heating the wood with methanol for *ca.* 30 hr. at 150°C. It has been calculated (*7*, *27*) that the content of acetyl groups in the nonresistant polysaccharides of *E. regnans* heartwood is equivalent to 25%, or more, acetylation. Hägglund, *et al.*, have obtained (*28*), a "xylan," representing about 50% of the xylan initially present in wood, from holocellulose prepared from a mixture of the woods of *Betula verrucosa* and *B. pubescens*. This polysaccharide contained 16.9 and 11.8%, respectively, of *O*-acetyl and uronic acid. Further investigations (*29*) by Bouveng, *et al.*, indicated that the *O*-acetyl groups, present in the polysaccharide, are attached to the xylose units mainly in the 3-position.

The comparative ease with which the *O*-acetyl groups may be removed, their lower content in heartwood as compared with sapwood, and the high acidity of heartwood relative to sapwood extracts (see Fig. 2 and Tables II, III, and IV for *E. regnans*) indicate that the *O*-acetyl groups may readily undergo hydrolysis. In fact it has been demonstrated recently

Table II. pH Values of Extracts from Tree (*IX*) of *E. regnans*

Age of wood, yr.	pH	Age of wood, yr.	pH
5	4.6	238	3.4
40	3.3	280	3.4
80	3.4	331	3.4
118	3.4	373	3.3
158	3.4	404	3.2
198	3.4	420	3.3

(*30*), for samples of several woods stored for 2 yr. at 48°C. and 100% R.H., that there is an exact correlation between the amount of acetic acid formed and the loss of *O*-acetyl groups. During the period of 2 yr., 70% of the total *O*-acetyl groups was converted to free acid in Douglas-fir and Sitka spruce and 50% in birch and beech. It was shown also that the volatile component, which comprised 80 to 90% of the total free acids, was acetic acid (identified by paper chromatography and the preparation of crystalline derivatives) and that the rate of hydrolysis of *O*-acetyl groups increased very considerably with increase in temperature.

A further aspect of the work mentioned above is of interest. It was observed that samples which became contaminated with growths of *Thermoascus aurantiacus* and *Monatospera lanuginosa* contained no free acids; whereas those samples protected against fungal attack (by the addition of mercuric chloride) liberated free acids in the normal manner. Similar results were obtained with *Aspergillus fumigatus* when the samples were stored at 25°C. These observations may be of importance in explaining anomalous behavior such as low acidity in wood from old trees because fungal infection is a commonplace in the centers of such trees; acidic degradation may render the old wood more susceptible to attack. It has even been suggested by Chattaway (*31*) that mycorrhizal fungi growing outwards from the center of the tree may stimulate the sapwood parenchyma cells to greater activity leading to their eventual death at the sapwood-heartwood transition area.

Extracts from E. regnans *Woods.* The variation in the acidity of extracts from the woods of several trees, as determined by pH measurements, is presented graphically in Fig. 2, and the detailed results from one tree (*ix*) are listed in Table II.

In some trees the pH values of extracts increased in a progressive manner from the center of the tree outwards. For example, in the case of tree (*xii*), the values rose from 3.49 at the center to 3.70 in the youngest heartwood and then to 4.80 in the sapwood. Sometimes a similar increase was observed across the sapwood; *i.e.*, for tree (*xi*), pH values were 4.62 and 5.23 for sapwood aged 4 and 1 yr., respectively. In other trees the pH values of heartwood extracts varied in a random manner, as shown in Table II.

The graphs in Fig. 2 provide evidence for: (1) a slight increase in acidity from the outside of the heartwood to the pith; (2) the concentration of hydrogen ions in the heartwood to be *ca.* 30 times (pH differences) as great as that in the sapwood; and (3) an increase, with age of tree (to 100 yr.), in the difference between the acidities of heartwood and sapwood.

Table III. *O*-Acetyl Contents of *E. regnans* Wood

Tree (*xv*)		Tree (*xvi*)	
Age of wood, yr.	*O*-Acetyl content, %	Age of wood, yr.	*O*-Acetyl content, %
4–6[a]	5.8	3–6[a]	6.0
7–8	5.8	8–9	6.0
10–11	5.9	11–12	5.8
14–15	6.4	15–16	6.0

[a] Sapwood; remainder heartwood.

Table IV. *O*-Acetyl Contents of *E. gigantea* Wood

Tree (*iv*)		Tree (*v*)	
Age of wood, yr.	*O*-Acetyl content, %	Age o, wood, yr.	*O*-Acetyl content, %
6–8[a]	2.2	4–8[a]	3.1
25–30	2.0	25–30	2.4
45–48	1.9	50–55	2.0
65–70	1.8	75–78	1.5
100–105	1.7	100–104	1.5
140–145	1.3	125–129	1.4
160–164	1.3	160–165	1.2
		188–194	1.2

[a] Sapwood, remainder heartwood.

These results are in accord with the liberation of acetic acid by autocatalysis of *O*-acetyl groups. The acids liberated in this way may be augmented either by "excretion" of free acids from the regions of active growth (*27*) or by the release of acids during the burst of activity (*31*) associated with the transition of sapwood to heartwood.

The graphs in Fig. 3 may tend to support the last-mentioned mechanism because of the apparent, sudden change in pH in the region of sapwood–heartwood transition. It will be noted that the pH values, calculated from titers, tend to approach the observed pH in the heartwood. This suggests that acids other than acetic acid are prevalent in the sapwood, and that the acids in the heartwood may be chiefly acetic acid.

O-Acetyl Contents of Eucalypt Woods. After removal of free acids, the *O*-acyl (calculated as *O*-acetyl) contents of several samples of wood were determined. The results for trees (*xv*) and (*xvi*) of *E. regnans* are given in Table III, and those for trees (*iv*) and (*v*) of *E. gigantea* are listed in Table IV.

In all cases, for the young trees of *E. regnans,* the *O*-acetyl content is high and relatively constant; these results would be expected because in young wood the extent of autocatalysis of *O*-acetyl groups would be small. The trend in tree (*xv*), which is the reverse of that which would be expected on the hypothesis of autocatalysis, may be explained by the observation (*32*) that fibers generally increase in length and in cell-wall thickness during the first 10 or more years of growth. These increases may be correlated with the decreasing rate of cambial generation of fiber cells

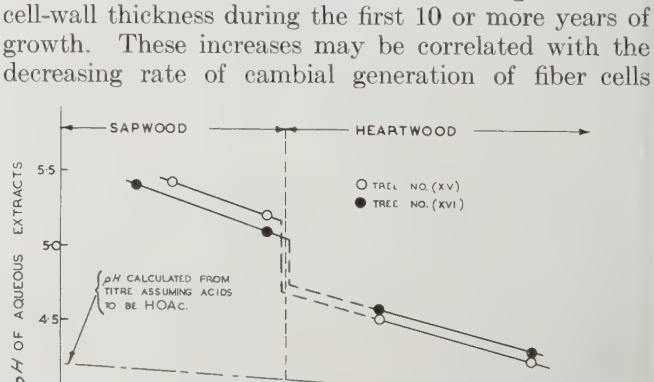


Fig. 3. The pH of extracts of wood removed from different positions along radii of young trees of* E. regnans*—mean values for heartwood and sapwood

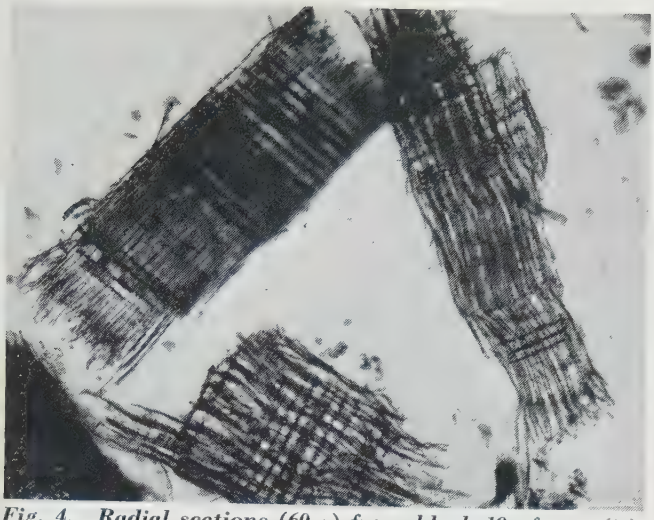


Fig. 4. Radial sections (60 μ) from block 19 of tree (iv), representing wood aged ca. 6 yr., after 30-min. defibration. Magnification ×40

(*33*) which should result in a decreasing content of non-resistant polysaccharides (consequent upon the increasing thickness of the cell wall), and hence of *O*-acetyl groups, with increasing distance from the center of the tree.

The results in Table IV provide evidence for the progressive autocatalysis of *O*-acetyl groups, the extent of hydrolysis increasing toward the center of the tree; *i.e.*, increasing with the time of exposure of the *O*-acetyl groups to the acidic aqueous medium existing within the tree. It may now be assumed, with a large measure of confidence, that the acidic medium existing within the tree should cause hydrolytic degradation of the wood components. The results of these staining experiments, together with the observations of Clarke (*11*) and Harlow (*13*) and those experiments which follow all lend support to this contention.

Mechanical Treatments

As discussed earlier, hydrolysis *in situ* may be expected to cause some modification to the interfiber cohesion forces existing within the wood; the more extensive the degradation, *i.e.*, the older the wood, the greater would be the expected modification of the cohesion forces. In order to test this hypothesis, radial sections removed from various positions along radial strips of wood were examined for ease of fiber separation both before and after different chemical treatments.

Fig. 6. As for Fig. 4, but wood aged ca. 150 yr.

Untreated Wood. Radial sections of *E. gigantea* wood were defibrated under standard conditions to produce the results depicted in Figs. 4 to 6; the photomicrographs show that the extent of defibration increases slightly with increases in the age of the wood.

Alkali-Pretreated Wood. The amount of defibration induced by pretreatment of wood with an aqueous solution of sodium hydroxide (5%) at room temperature (Figs. 4, 7, and 10) is very little greater than that caused by acid hydrolysis within the tree (Figs. 4 to 6). However, increasing times of alkali pretreatment on sections which had been subjected to acid prehydrolysis *in situ* resulted in increasing degrees of fiber separation during mechanical treatment (cf. Figs. 5, 8, and 11 with Figs. 6, 9, and 12), the greatest effect being attained in the material represented by Fig. 12. It will be noted that the 24-hr. treatment with alkali is not much more effective, with respect to ease of fiber separation, than the 30-min. treatment—see also (*34*). the observed behavior indicates that at least two factors are responsible for interfiber cohesion: one which is affected by acids and the other by alkalies.

These observations may be of practical importance during mechanical and semichemical pulping because they suggest that for minimum consumption of mechanical energy the wood should be subjected to an

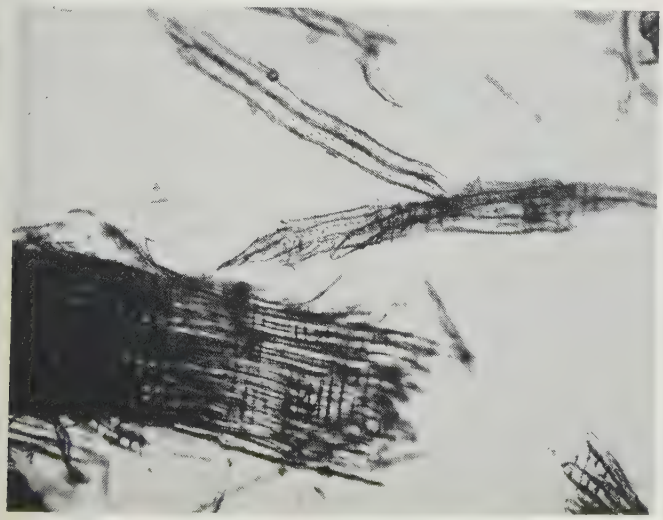


Fig. 5. As for Fig. 4, but wood aged ca. 100 yr.

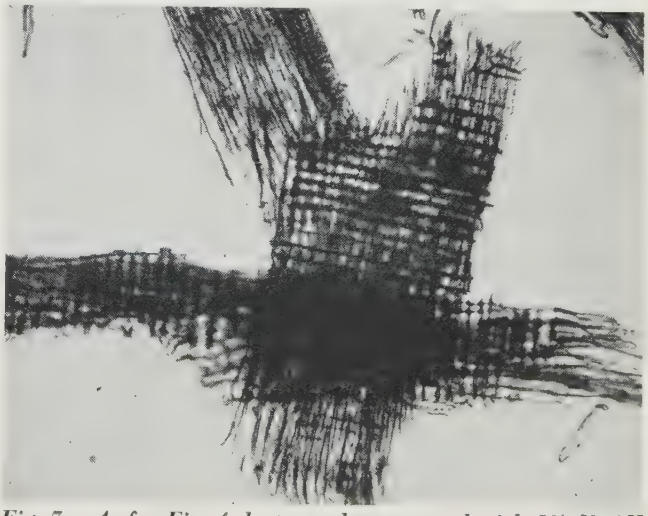


Fig. 7. As for Fig. 4, but wood pretreated with 5% NaOH for 30 min. at 20°C.

optimum acid prehydrolysis before alkali treatment and, perhaps, vice versa: however, acid pretreatment may affect adversely the papermaking properties of the pulp. This is a matter requiring further investigation, although it is known (*3*) that acid prehydrolysis within the living tree is advantageous with respect to groundwood production.

Figures 13 to 15 illustrate the effect of 0.05% alkali solutions. The hot, dilute alkali solution is more effective with respect to fiber separation than the cold, more concentrated (5%) alkali solution. This is indicative of reaction control involving the scission of chemical bonds rather than control by physico-chemical forces such as swelling.

Acid and Alkali Pretreatments. When the sections cut from blocks of wood removed from near the outside of each stem [blocks 18, 19, 28, and 29, from trees (*iv*) and (*v*)] were treated for increasing times with

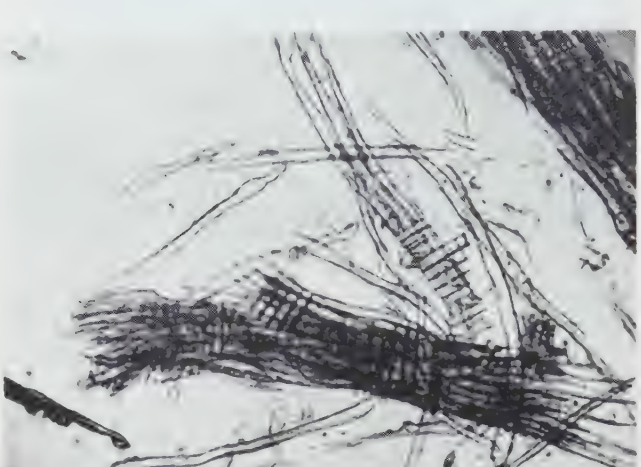


Fig. 8. ***As for Fig. 5, but wood pretreated with 5% NaOH for 30 min. at 20°C.***

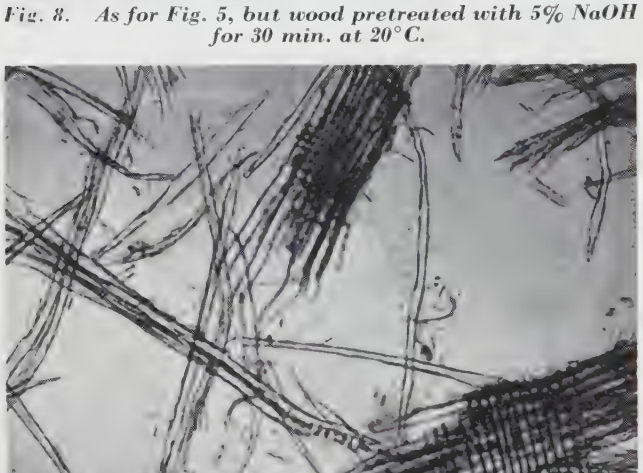


Fig. 9. ***As for Fig. 6, but wood pretreated with 5% NaOH for 30 min. at 20°C.***

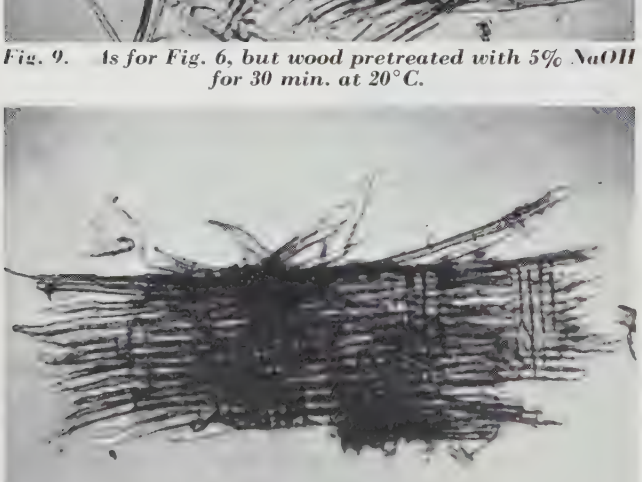


Fig. 10. ***As for Fig. 7, but 24-hr. pretreatment***

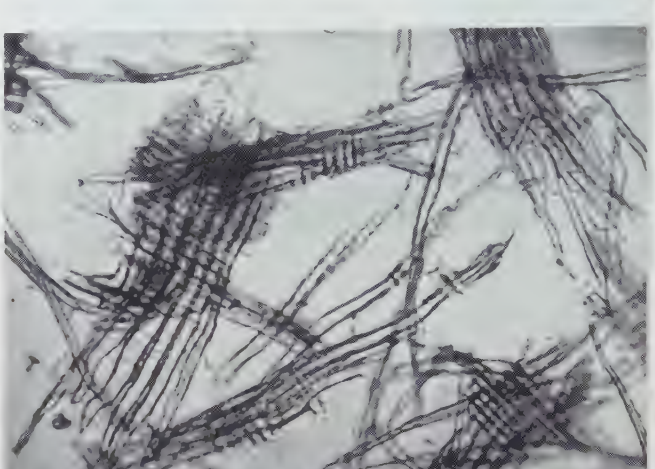


Fig. 11. ***As for Fig. 8, but 24-hr. pretreatment***

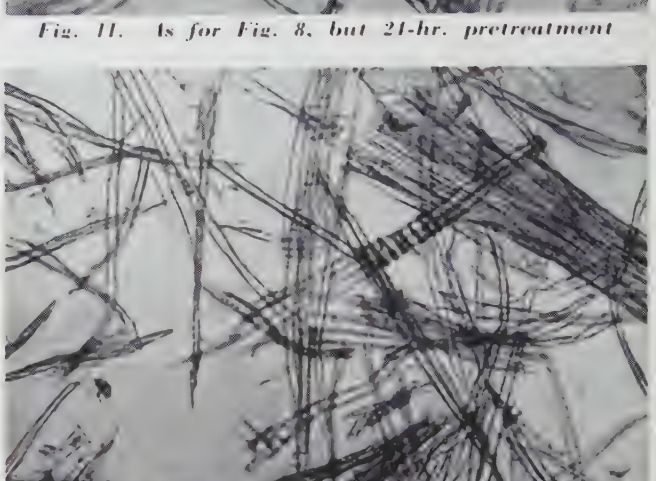


Fig. 12. ***As for Fig. 9, but 24-hr. pretreatment***

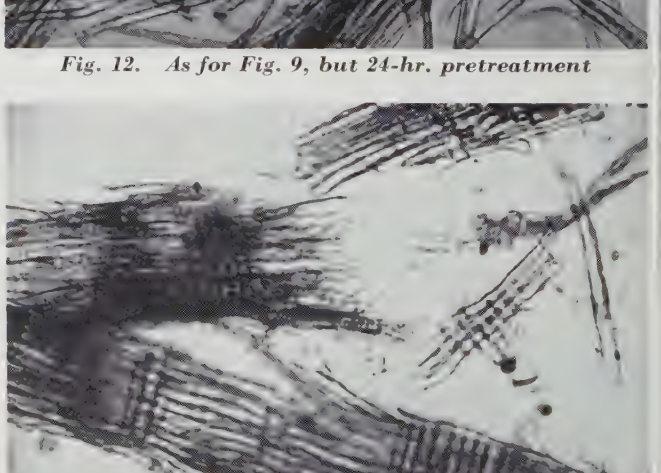


Fig. 13. ***As for Fig. 4, but wood pretreated with 0.05% NaOH for 280 min. at 98°C.***

6% HCl and then with 5% solutions of sodium hydroxide at 20°C. for 30 min., followed by standard disintegration in the defibrator, it was found that the degree of defibration increased with increasing times of acid hydrolysis.

Treatments with Acidic Buffer Solutions. Results analogous to those given above were obtained when a buffer solution of pH 3.8 was used for prolonged times at 98°C. (Figs. 16 to 18). The milder acidic conditions (pH 3.8) caused less damage to the fibers for similar degrees of fiber separation than the more drastic conditions (6% HCl). These results suggest that hydrolysis *in vitro* at elevated temperatures, for comparatively short periods of time, produces effects equivalent to those produced by hydrolysis *in situ* at atmospheric temperatures for periods of many years.

It was observed that the degree of fiber separation produced by standard mechanical treatment was similar for sapwood which had been heated at 98°C. with the buffer solution at pH 3.8 for *ca.* 100 hr. and for wood which had been subjected to the action of acid (average pH say, 3.8—see Fig. 2) within the tree for about 100 hr. at a mean annual temperature of *ca.* 8°C. If it is assumed that the temperature coefficient, Q, of the hydrolytic reaction may be calculated as:

$$Q = \frac{k_1}{k_2} = \frac{t_2}{t_1} \qquad (1)$$

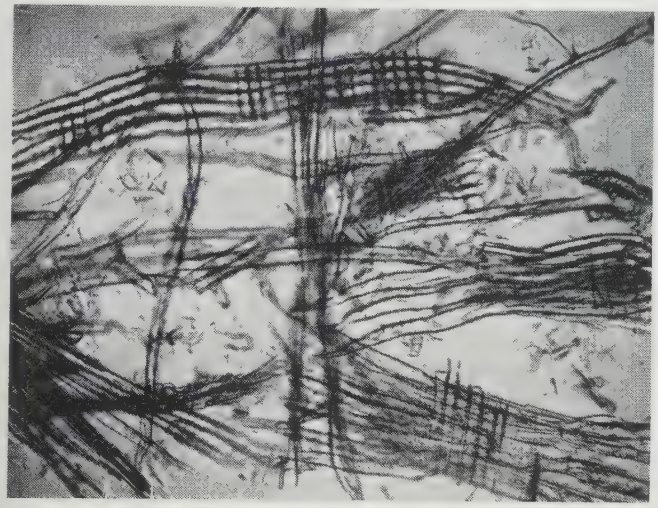


Fig. 14. As for Fig. 5, but wood pretreated as for Fig. 13

Fig. 15. As for Fig. 6, but wood pretreated as for Fig. 13

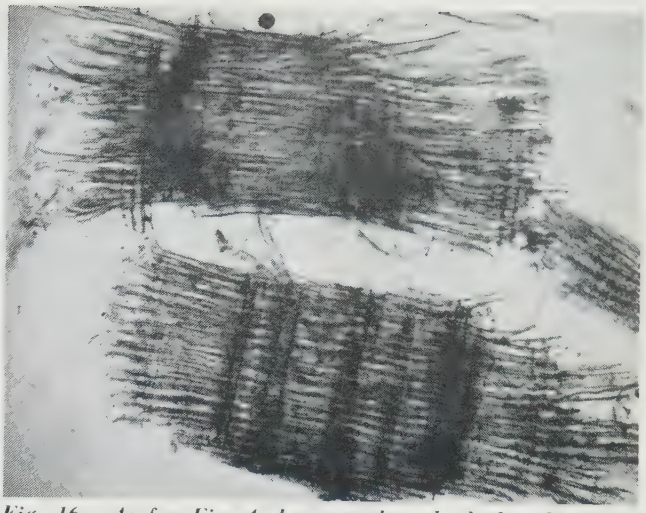


Fig. 16. As for Fig. 4, but wood prehydrolyzed with a buffer solution at pH 3.8 for 195 min. and then treated with 5% NaOH for 30 min. at 20°C.

Fig. 17. As for Fig. 16, except that the acid prehydrolysis was continued for 169 hr.

Fig. 18. As for Fig. 17, except that the alkali treatment was omitted

Table V. The Percentages of Free Fibers Produced by Defibration of Sections After One and Two Cycles of Delignification

	Treatments	—Fiber separation, % Outside	Halfway	Center
1	Chlorite delignification cycle; 30 min. in 5% NaOH at 20°C.; 15 sec. in defibrator	23	60	84
2	Chlorite delignification cycles; 30 min. in 5% NaOH at 20°C.; 5 sec. in defibrator	24	76	88

where k_1 and k_2 are the velocity constants and t_1 and t_2 are the times to produce equivalent potential ease of mechanical defibration, then:

$$Q_{90}^{\circ} \simeq \frac{100 \cdot 365 \cdot 24}{100}$$

$$\sim 8,760$$

Thus $$Q_{10}^{\circ} \simeq \sqrt[9]{8,760}$$

$$\simeq 2.7$$

This value of Q_{10}° is approximate and is somewhat higher than that (2.4) obtained for the hydrolysis of partially delignified wood sections (*1*); but it is of sufficient magnitude to suggest that the scission of interfiber covalent bonds governs the ease of mechanical defibration of wood as well as of partially delignified wood (or holocellulose).

Further Treatments with Buffer Solutions. To compare the action of hydrogen and hydroxyl ions on wood, radial sections from young wood [tree (*xv*)] were hydrolyzed separately with buffer solutions of pH 3.5 and 10.5 at 72°C. for increasing periods of time; *i.e.*, the effect on the potential ease of defibration of hydrolysis with equal concentrations of hydrogen and hydroxyl ions was studied. The results showed that hydroxyl ions were 1000 to 4000 times as effective as hydrogen ions—this ratio is of the same order of magnitude as that obtained by calculations during the staining experiments.

Partial Delignification and Mechanical Treatments
E. gigantea *Wood*

Radial sections, removed from the blocks of wood located as in Fig. 1, were given increasing numbers of delignification cycles with hot, acidified sodium chlorite solution—see Figs. 19 to 24. It will be noted that two delignification cycles are only a little more effective than one cycle for increasing the ease of fiber separation; however, the ease of defibration increases from the outside toward the center of the trees. As was observed in previous work (*1*), the radial parenchyma (rays) seem to restrict the separation of fibers; see Figs. 8 to 11, 13, 14, 16 to 18, and 23.

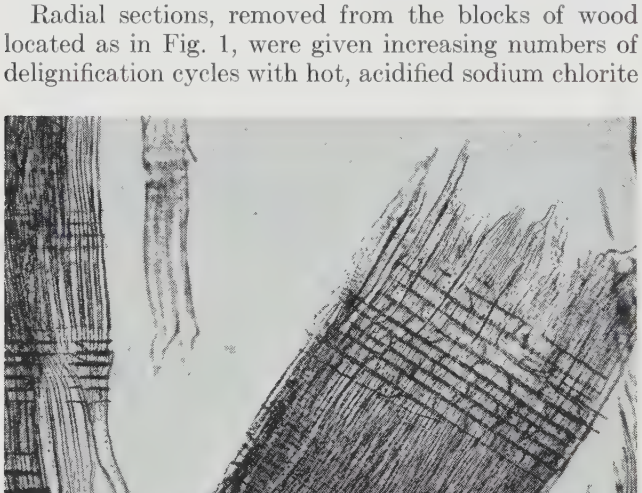


Fig. 19. Radial sections (60 μ) from block 28 of tree (v), representing wood aged ca. 50 yr., after one delignification cycle and 5-min. defibration. Magnification ×40

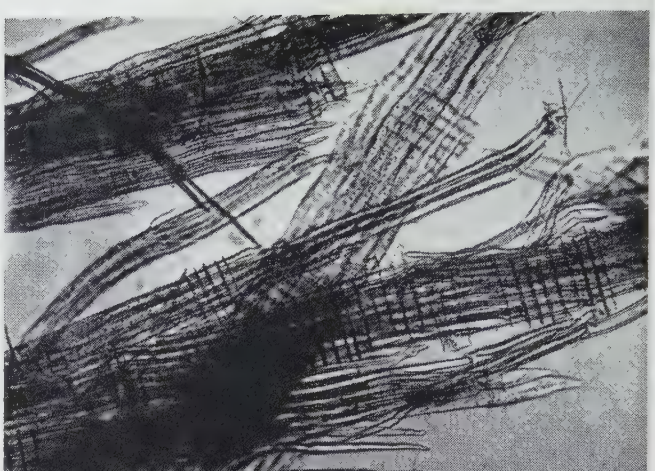


Fig. 20. Radial sections (60 μ) from block 25 of tree (v), representing wood aged ca. 130 yr., after one delignification cycle and 5-min. defibration. Magnification ×40

The effect of increased times of disintegration, on sections which have been given two cycles of delignification, may be gaged by comparing Figs. 25 to 27 with Figs. 22 to 24. Two cycles of delignification were found to be more effective in increasing the ease of defibration than treatment of the wood with cold (30 min. at 20°C.) 5% solutions of sodium hydroxide (cf. Figs. 7 to 9 with Figs. 25 to 27), but not much more effective than treatment of wood with hot, dilute alkali (see Table I, and compare Figs. 13 to 15 with Figs. 25 to 27). The ease of defibration increased in a very marked manner when sections of partially delignified wood were treated with solutions of alkali (Figs. 28 to 30). Once again the effects of hydrolysis *in situ* are reflected in the treated sections of wood.

Table V demonstrates the extent of defibration brought about by defibration of sections which have been given delignification and alkali treatments. The

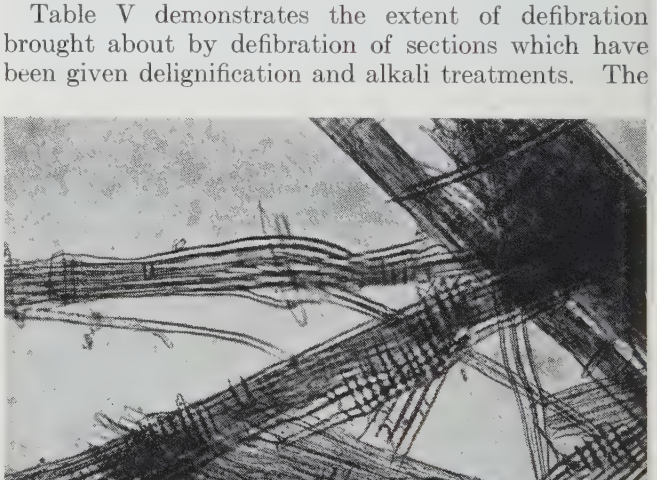


Fig. 21. Radial sections (60 μ) from block 22 of tree (v), representing wood aged ca. 180 yr., after one delignification cycle and 5 min. defibration. Magnification ×40

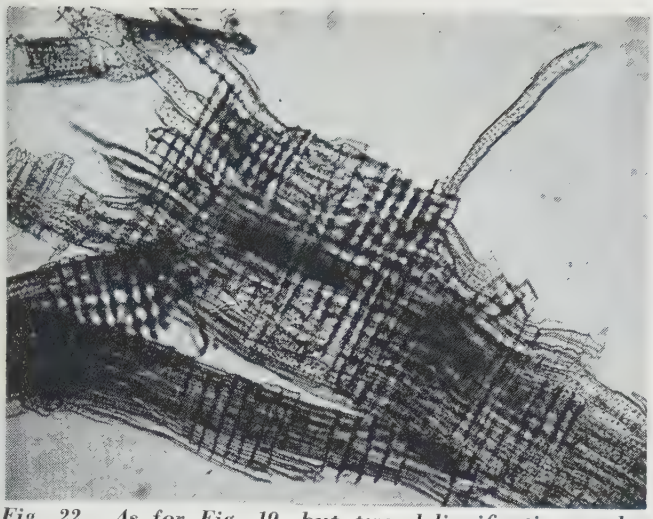


Fig. 22. As for Fig. 19, but two delignification cycles applied

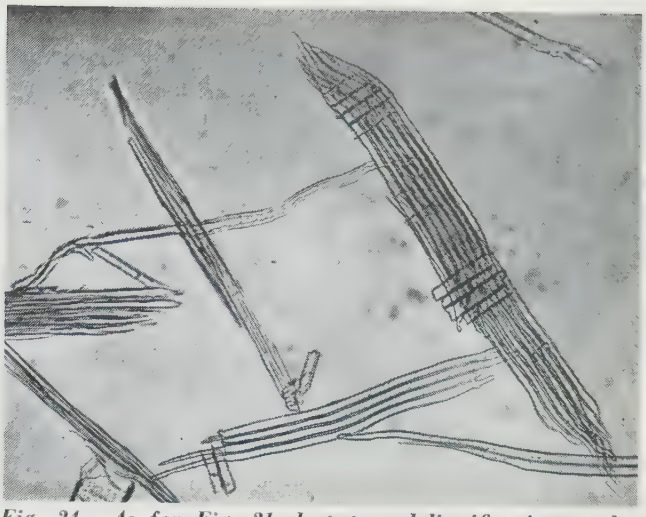


Fig. 24. As for Fig. 21, but two delignification cycles applied

times of defibration for one and two cycles of delignification, in the case of tree (*v*), were 15 and 5 sec., respectively. The results indicate that, for approximately the same degree of fiber separation, the material from the first cycle of delignification consumed at least 300% more power than that consumed by the material from the second cycle.

E. regnans *Wood.* Many of the *E. regnans* samples were examined for ease of cell separation after three cycles of delignification; this procedure enabled the percentages of free fibers to be estimated quite readily. Figure 31 is a graph of the results for wood removed from the region including the tenth growth ring from the pith of each tree. The percentage of free fibers increases with increase in the age of the wood.

When radial sections removed from different positions along the radii of young trees were examined, it was found that the ease of defibration was more or less constant at a low value. For older trees the ease of fiber separation increased with age of wood, as shown graphically in Fig. 32.

It was observed, for old *E. regnans* trees and for tree (*xvii*) of *E. diversicolor*, that the degree of fiber separation increased rapidly, in the direction of the pith, from the position where the sections began to stain mainly green with safranin and light green. Thus, in the original wood, the double stain appears to act as an indicator of the extent of hydrolysis which has occurred within the tree rather than as an indicator of the relative proportions of lignin and cellulose.

In addition to subjection to three cycles of delignification, samples from several old trees were given one and two cycles. During the defibration treatments these samples separated into bundles of fibers (with few free fibers), the number per bundle tending to decrease with increase in the age of wood and with increase in the number of delignification cycles.

Acid Hydrolysis in vitro *and Partial Delignification.* An attempt was made to reproduce in the laboratory the acid hydrolysis believed to occur in a living tree. Radial sections were cut from the 12 outermost growth rings of heartwood in tree (*xii*) and were treated at 98°C. for increasing periods of time with a buffer solution of pH 3.8. After hydrolysis the sections were given three cycles of delignification and then defibrated under standard conditions. During the first few hours' hydrolysis the degree of defibration did not increase appreciably from that obtained with unhydrolyzed sections, but thereafter the extent of fiber separation increased as the time of hydrolysis was increased.

On staining with safranin and light green, the hydrolyzed sections stained mainly green at the time of hydrolysis, when the ease of defibration began to increase rapidly; *i.e.*, the staining behavior was similar

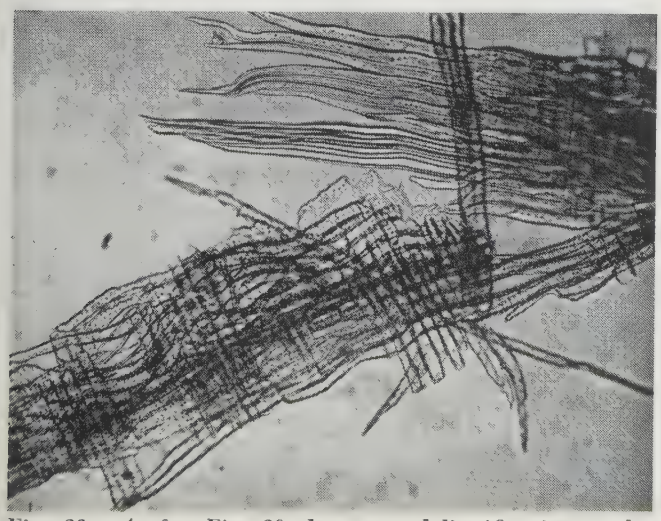


Fig. 23. As for Fig. 20, but two delignification cycles applied

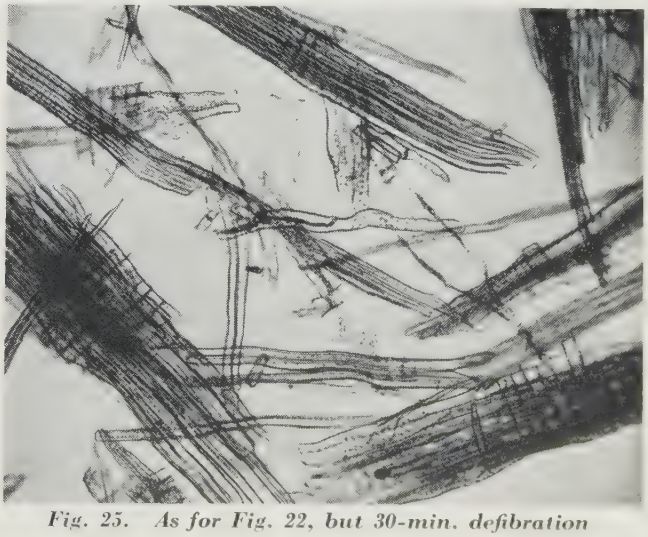


Fig. 25. As for Fig. 22, but 30-min. defibration

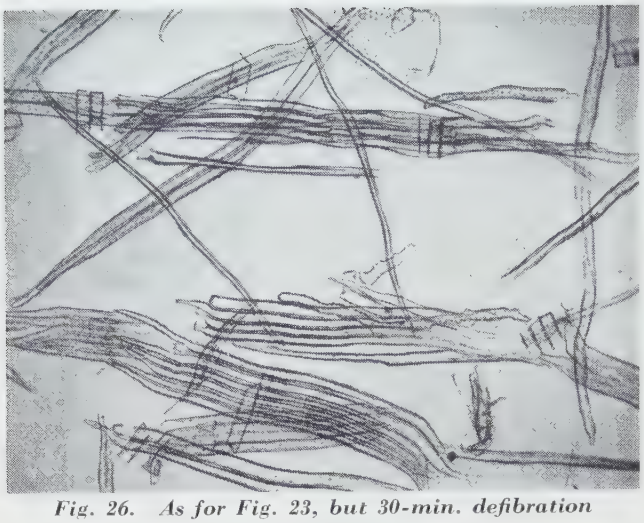


Fig. 26. As for Fig. 23, but 30-min. defibration

to that obtained in the case of hydrolysis *in situ*. This work was repeated while reversing the order of delignification and hydrolytic treatments; the reversal of treatments had little effect on the rate of fiber separation.

Progressive Delignification and Ease of Defibration. It is known that lignin plays some role in interfiber cohesion. The effect of quantitatively measured removal of lignin on the percentage production of free fibers was studied. After the desired time of reaction in acidified sodium chlorite solution the sections were immersed for 20 min. in 0.1*N* solutions of sodium hydroxide at room temperature, and then given a standard defibration treatment. The results are plotted as a sigmoid curve in Fig. 33.

A rapid increase in the ease of defibration occurs after 30 to 40% of the lignin is removed, almost complete fiber separation occurring readily when 60 to 70% delignification is achieved. The practical importance of these results, when applied to commercial pulping, should not be overstressed because the actual method of delignification used and the location within the cell wall from which the lignin was removed may influence both the ease of defibration and the fiber-bonding potentialities of the pulp during the process of papermaking. The latter property may be expected to be influenced, also, by the actual mode of interfiber scission; *i.e.*, whether, for example, the scission occurs at the intercellular layer or within the cell wall.

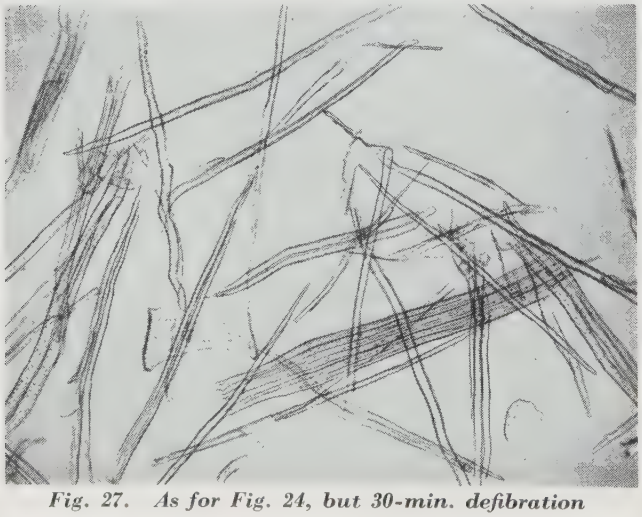


Fig. 27. As for Fig. 24, but 30-min. defibration

Fig. 28. As for Fig. 22, but posttreatment involved action of 5% NaOH for 30 min. at 20°C., followed by 5-sec. defibration

Hydrolysis Use and Chemical Modification of Wood

Evidence has been adduced (see introduction) in favor of the chemical modification of wood due to the prolonged hydrolysis *in situ*, the changes produced being such that the nonresistant polysaccharides are rendered potentially soluble in water; their actual dissolution occurs concomitantly with subsequent delignification. These changes have been observed in an old tree used for groundwood pulp production (*3, 8*). It was decided to obtain more reliable data by examining the variation, in proximate chemical properties, along radial strips of wood removed from two trees; namely tree (*ix*) of *E. regnans* and tree (*xvii*) of *E. diversicolor*. The results are given in Table VI and in Figs. 34 and 35.

The contents of lignin and holocellulose decrease as the age of the wood increases, whereas the pentosan content of the wood remains more or less constant for *E. regnans* and increases with increase in age of wood for *E. diversicolor*.

However, the losses in pentosan content when the wood is converted to holocellulose are the most reliable indication of hydrolytic degradation; these losses increase progressively with increase in the age of wood. This behavior is very similar to that obtained when

Fig. 29. As for Fig. 23, but post treatment involved action of 5% NaOH for 30 min. at 20°C., followed by 5-sec. defibration

Table VI. Variation of Proximate Chemical Properties with Age of Wood

Results expressed as per cent of original wood

Age of wood		Lignin in wood		Pentosan in wood		Holocellulose yield[a]		Pentosan in holocellulose	
E. regnans	E. diversicolor	E. regnans	E. diversicolor	E. regnans	E. diversicolor	E. regnans	E. diversicolor	E. regnans	E. diversicolor
10		26.9		18.8		82.1		18.3	
	25		22.7		16.0		79.3		16.0
80		26.2		19.8		80.7		18.6	
	75		22.6		16.0		78.0		15.8
165		24.7		20.3		81.3		18.0	
	105		19.6		16.2		78.8		15.5
245		23.9		20.3		83.4		19.2	
	155		17.7		16.8		79.0		15.7
330		23.6		20.5		80.5		18.2	
	195		17.8		18.0		76.0		15.3
400		23.8		20.7		75.6		18.1	
	245		16.5		18.3		74.8		14.8
420		23.6		20.2		74.8		16.6	
	275		15.7		18.3		74.7		14.1
428		26.4		20.5		72.5		16.7	
	285		15.9		17.8		76.2		15.9

[a] Holocellulose represents the residue obtained after four cycles of delignification.

young *E. regnans* wood is subjected to mild hydrolysis; typical results from mild methanolysis of this wood are listed in Table VII.

Natural variations in the contents of lignin and holocellulose may be superimposed on the results given in Table VI. There is no reliable method of determining the extent of the natural variations. However, the results of holocellulose analyses on sapwood and young heartwood from many trees of *E. regnans* indicate that the holocellulose content rarely falls below a value of 80%; therefore the observed decrease in holocellulose content may be attributed mainly to the dissolution, during delignification, of the nonresistant polysaccharides which were rendered potentially soluble in water during the prolonged hydrolysis within the tree — the losses in pentosan content, of course, support this contention. Likewise the decrease in lignin content, with increase in age of wood, may perhaps be correlated with the extent of hydrolytic degradation because Cohen and Harris (*35*) have shown that hydrolysis of maple wood with dilute solutions of acid results in losses of lignin—the lignin content falling from 21.5 to 17.3%.

GENERAL INTERPRETATION OF RESULTS

The experiments with microbiological stains indicate that progressive changes occur within the wood of living trees; the older the wood the more extensive are the changes in staining behavior.

Acetic acid, produced by the hydrolysis of *O*-acetyl groups, appears to be responsible for the hydrolytic degradation of wood within living trees; the decrease in the content of *O*-acetyl groups and the increase in the concentration of acetic acid may be correlated with increase in the age of wood. The changes in staining behavior are related to the hydrolytic degradation of wood rather than to marked changes in the relative proportions of lignin and cellulose within the wood.

Table VII.[a] Proximate Analyses of Wood After Treatment with Methanol at 150°C.

Results expressed as per cent of original wood

Time of treatment, hr.	Lignin	Pentosan in wood	Pentosan in holocellulose	Holocellulose
0	22.3	16.6	16.6	80.9
4	19.4	15.8	14.7	76.8
20	15.2	15.5	11.8	68.5
36	12.0	15.5	11.1	66.2

[a] Stewart, *et. al.* (*7*).

The hydrolytic degradation has a significant effect on one of the important intrinsic properties of wood; namely, the degree of interfiber cohesion. The magnitude of this property, which varies inversely with the ease of defibration, decreases with increases in the extent of hydrolytic degradation; *i.e.*, the older the wood, or the longer the wood has been subjected to hydrolytic degradation, the lesser the degree of interfiber cohesion.

The hydrolysis occurring *in situ* may be simulated in the laboratory using young wood and hydrolytic reagents. Alkalies appear to be of the order of 10^3 times as effective as acids in influencing the degree of interfiber cohesion. The magnitude of the temperature coefficient ($Q_{10°}$, 2.4 to 2.7), involved in the hydrolytic reactions, suggests that increases in the ease of fiber separation are controlled mainly by the scission of covalent chemical bonds existing between the components of adjacent fiber cells.

The Existence and Nature of Interfiber Bonds

For simplicity it may be assumed, initially, that only one species of covalent bond is involved in interfiber cohesion. Can we deduce the possible nature of the interfiber bonds? The bonds must be more scissile toward hydroxyl than toward hydrogen ions. On this

Fig. 30. As for Fig. 24, but post treatment involved action of 5% NaOH for 30 min. at 20°C., followed by 5 sec. defibration

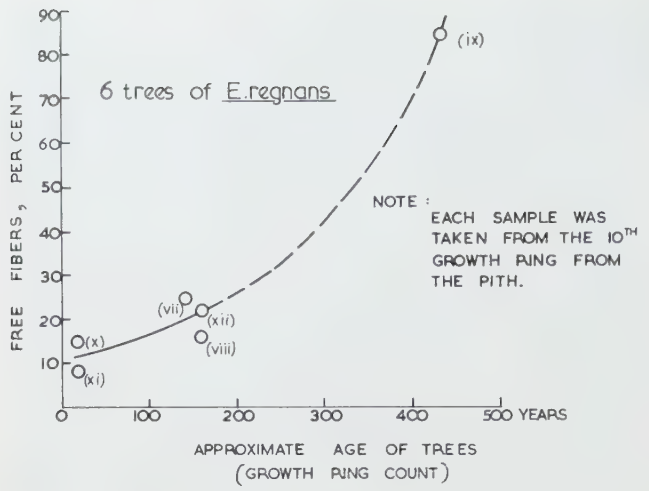


Fig. 31. Ease of defibration of partially delignified wood sampled from six trees of **E. regnans**

basis normal glycosidic bonds, existing between carbohydrate components, must be eliminated because they are relatively stable in the presence of alkali but are cleaved readily in the presence of acid.

Lignin appears to play a part in interfiber cohesion because of the observed marked increase in case of fiber separation which occurs when wood is partially delignified. The noncellulosic polysaccharides, which contain nearly all of the uronic acid units in wood (*7*), appear to be situated chiefly in the regions of the intercellular layer and outer portions of the cell wall (*6*). The microspectrographic work of Asunmaa and Lange (*36*) has demonstrated that carboxyl groups are concentrated in the intercellular layer and outer portions of the cell wall and that their concentration falls off, almost linearly, to zero at the cell lumen. Thus the indicated distribution of noncellulosic polysaccharides given above is feasible. Lange (*37*) has shown that lignin is distributed in much the same way as the carboxyl groups. The above evidence suggests that lignin and the noncellulosic polysaccharides are intimately associated and exist in those regions where interfiber bonds would be expected to occur. Stewart,

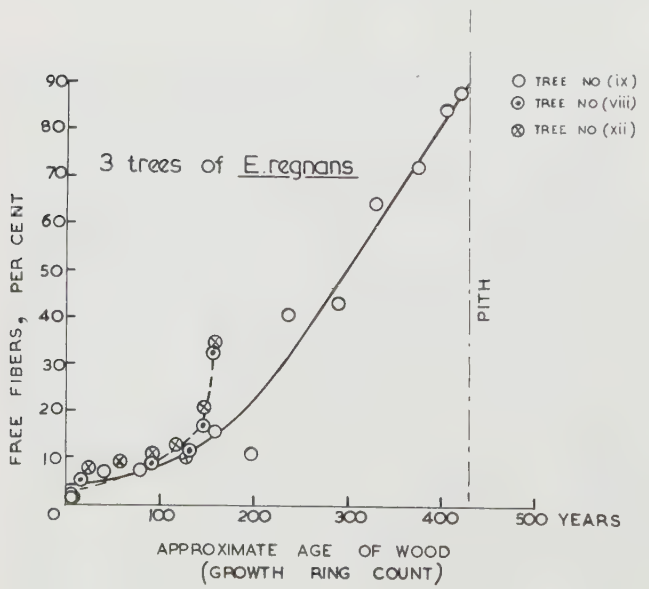

3 trees of E.regnans
TREE NO (ix)
TREE NO (viii)
TREE NO (xii)
PITH
FREE FIBERS, PER CENT
APPROXIMATE AGE OF WOOD (GROWTH RING COUNT)
0 100 200 300 400 500 YEARS

Fig. 32. Ease of defibration of partially delignified wood sampled along the radii of three trees of **E. regnans**

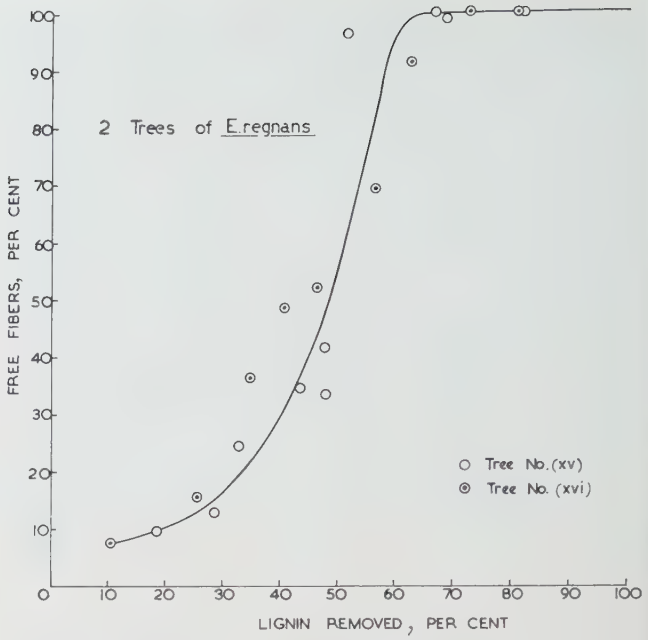


Fig. 33. Progressive delignification and its effect on the ease of fiber separation

et al., have obtained evidence (*6*, *7*) which indicates that lignin is chemically bonded to the noncellulosic polysaccharides.

Sarkar, *et al.*, have produced evidence (*38*, *39*) of the existence of a bond between uronic acid and lignin in jute by showing that the acid value is doubled on delignification or alkali extraction, and Foster, *et al.*, have postulated (*40*) a uronic acid–lignin bond in order to explain why the uronic acid of *E. regnans* wood is hydrolyzed much more slowly than would be expected if it were associated only with pentosans. Stewart, *et al.*, have shown (*41*) that during the maturation of fiber cells, more than half of the lignin is laid down after the deposition of most of the cellulose, and Wardrop has demonstrated (*17*) that during the differentiation of fibers, the intensity of staining with ruthenium red diminishes as lignification progresses. The results of hydrolysis of wood *in vitro* and *in situ* indicate that

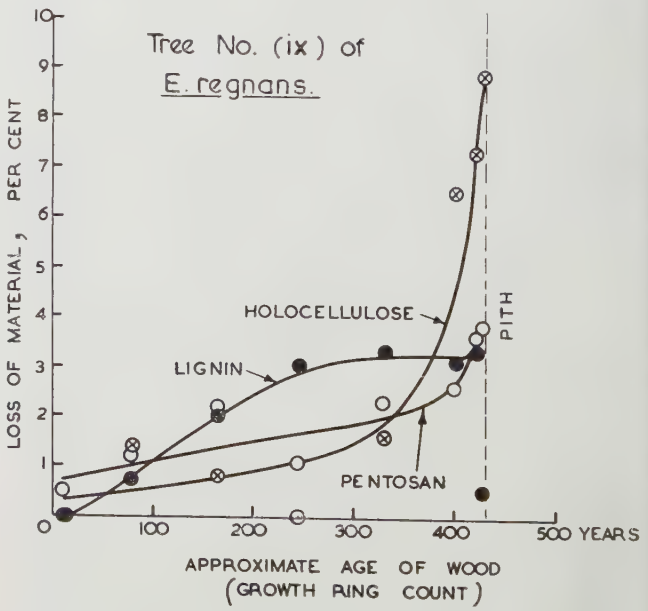


Fig. 34. Losses of materials other than lignin during delignification, and apparent losses of lignin from **E. regnans** *wood as a result of hydrolytic degradation* **in situ**

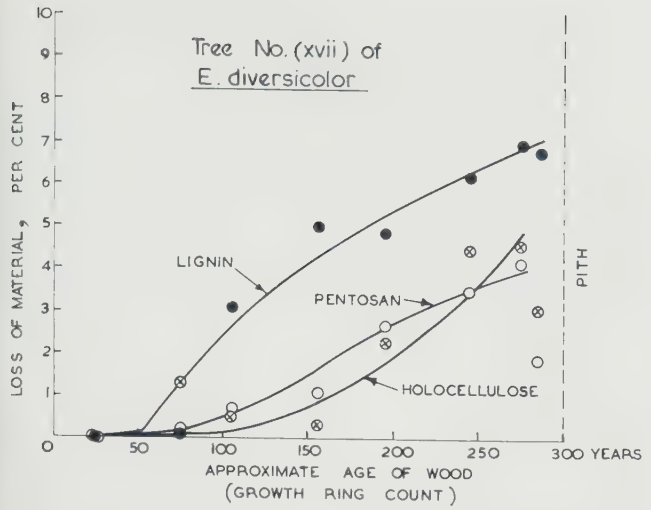


Fig. 35. Losses of materials other than lignin during delignification, and apparent losses of lignin from* E. diversicolor *wood as a result of hydrolytic degradation in situ

the intensity of staining with ruthenium red increases as the time of hydrolysis is increased; *i.e.*, the concentration of free carboxyl groups increases during hydrolysis. Alkali solutions are much more effective than acids in catalyzing the liberation of free carboxyl groups and in causing the liberation of lignin from chlorine holocellulose (*7*). Taylor, *et al.*, have shown (*42*) that the carboxyl groups are associated chiefly with uronic acids. The above evidence suggests that many uronic acid units are linked chemically to lignin; some may be linked to other plant constituents (*43, 44*).

The type of bond involved in the linkage of uronic acid to lignin is likely to be an ester bond rather than a glycosidic bond because many workers have shown that the 4-*O*-methyl-D-glucuronic acid units [*E. regnans* contains these units (*45*)] of the noncellulosic polysaccharides of woods are attached glycosidically to the xylose units of the polymer chains. Thus, during lignification, lignin units can become attached to the uronic acid units by the formation of lignyl 4-*O*-methyl-D-glucuronate side-chains linked on to the xylose units of the main chains of the noncellulosic polysaccharides through the 2-*O*-positions (the 3-*O*-positions probably contain *O*-acetyl groups). This linkage process, and the possible further addition of lignin units to those already incorporated in the side-chains, may be an important physiological process which can represent a "detoxication" mechanism that is applicable to the fiber cell wall (*27*).

Other types of chemical combination between lignin and polysaccharide have been discussed by Brauns and Yirak (*46*). However, no one type of bond, apart from the ester type, seems to satisfy all of the observations outlined above.

Brauns and Yirak also state that "ester linkage between lignin and uronic acids seems improbable because, in this case, the carbohydrates would be soluble in Schweizer solution as such esters would be saponified by the alkaline copper ammonium hydroxide solution." This statement is correct only if one species of linkage is considered possible. The experiments with *E. regnans* wood indicate that hydrolysis either with acid or with alkali is much less effective (see Figs. 4 to 12) than consecutive treatments with acid and alkali. Thus the existence of more than one type (say two types) of bonding is probable, the bonds being such that one species is more labile toward alkali than toward acid and vice versa.

The possibility of the existence of interfiber bonds between the polysaccharides of adjacent cells, as well as those involving lignin and polysaccharides, should not be overlooked. The nonresistant polysaccharides (isolated by extraction with aqueous 5% solutions of sodium hydroxide) of *E. regnans* wood appear to contain *ca.* 3% of *O*-acetyl groups (*47*). Hence it is possible that these groups, perhaps present in the wood as orthoacetate groups, may be involved in interfiber bonding.

Pulping

The term pulping as used in this paper may be defined as a process or series of processes which tend to produce suspensions of free fibers from wood. The ultimate use requirements of the pulp (*e.g.*, papermaking) may render necessary either certain changes to the pulping procedure or certain additional treatments to the pulp.

The occurrence of hydrolysis *in situ*, and the concomitant weakening of interfiber cohesion, is of particular significance when mechanical energy assumes major importance in pulping; *i.e.*, when mechanical or semichemical pulping processes are used. Thus woods from old trees, especially those from hardwoods which contain appreciable quantities of *O*-acetyl groups, would be expected to consume less mechanical energy during pulping and to produce pulps exhibiting less damage to fibers (*1*) than those produced from young trees. Hence the observation, by Somerville and Burkitt (*3*), that old "mellow" wood (*E. regnans*) generally yields better groundwood pulps than those from young trees, may be correlated with the extent of hydrolysis which has occurred *in situ*.

These workers have observed also that wood affected with brittle heart never yields good groundwood pulps (owing to excessive numbers of microscopic compression failures rather than to a decrease in ease of fiber separation), and that the "mellow" heartwood, which extends from just outside the region of brittle heart toward the sapwood in old trees, yields groundwood pulps with good papermaking properties. The sapwood from old trees and the wood from young trees (1 to 2 ft. d.b.h.) generally yield poor groundwood pulps. These properties are consistent with the occurrence of acid hydrolysis within the living tree; thus, because of the weakening of interfiber cohesion caused by acid hydrolysis, increase in age of wood corresponds with increase in the ease of grinding. Excessive acid hydrolysis, which would be expected near the centers of old trees, may modify interfiber cohesion and chemically affect the cell wall to such an extent that the mechanical forces existing within the bole of a tree (*48, 49*) may induce the formation of the numerous, minute compression failures (*49a*) characteristic of brittle heart. The fact that brittle heart occurs much more often in hardwoods than in softwoods may be related to the presence of numerous *O*-acetyl groups in the former but not in the latter woods.

By means of acidic prehydrolysis it is possible to

render young wood equivalent to, with respect to ease of mechanical pulping, or better than old wood from aged trees. If only a single pretreatment is used then alkali is more efficient than acid, and the older the wood the more beneficial is the alkali treatment. The increase in pulping efficiency, in this case, is due to the combined effects of acid prehydrolysis (*in situ*) and alkali prehydrolysis (*in vitro*).

When thin microtome sections of wood are used there is some evidence of slight diffusion control over the penetration of reagents. For optimum efficiency during prehydrolysis reactions the conventional wood chip is too large; some form of thin shaving should be employed where this is practicable.

EXPERIMENTAL

Wood Samples

(a) Eucalyptus regnans *F. Muell.* Normal wood from the 8 to 10th growth rings of a 15-yr.-old tree from (*i*) and from the *ca.* 150th growth ring of a 200-yr.-old tree (*ii*).

(b) Eucalyptus nitens *Maid.* "Normal" wood from the 8 to 10th growth rings of a 15-yr.-old tree (iii) containing appreciable amounts of tension wood.

(c) Eucalyptus gigantea *Hook f.* Two trees, numbers (*iv*) and (*v*) aged, respectively, *ca.* 166 and 196 yr.; within two weeks of felling, a 2-in. deep by 2-in. wide strip of wood was removed from the greatest "diameter" of each tree; small blocks of wood were cut out of each strip at the positions shown in Fig. 1. Microtome sections were cut from the blocks listed in Table VIII.

Table VIII

Tree no. (IV) (166 yr.)			*Tree no. (V) (196 yr.)*		
Block no.	*Approximate growth ring no.*[a]	*Approximate age of wood, yr.*[a]	*Block no.*	*Approximate growth ring no.*[a]	*Approximate age of wood, yr.*[a]
11	2–3	164	21	1–2	194
12	10–12	155	22	12–14	183
13	32–34	133	23	28–29	167
15	71–73	94	25	67–69	128
17	108–110	57	27	113–116	81
18	...	...	28	140–150	41
19	156–163	7	29	176–188	12

[a] The growth rings were counted from the cambium inwards. It was assumed, in order to estimate the age of the wood, that a growth ring was laid down each year.

According to data supplied by the Commonwealth Bureau of Meteorology, the *E. gigantea* trees (and the *E. regnans* trees from Tasmania) grew for most of their lives at a mean annual temperature of 8°C.

(d) Pinus radiata *D. Don.* "Normal" wood from the 10 to 12th growth rings and compression wood from the 15th growth ring of an 18-yr.-old tree (*vi*) containing large amounts of reaction wood formed after the 10th yr. of growth.

(e) Eucalyptus regnans *F. Muell.* Blocks of normal wood were removed at *ca.* 2-in. intervals along a "radius," essentially as described under (c), from each of the following trees in Table IX.

Table IX

Tree no.	*Approximate age, yr.*	*Tree no.*	*Approximate age, yr.*
(*vii*)	140	(*xii*)	160
(*viii*)	160	(*xiii*)	94
(*ix*)	430	(*xiv*)	47
(*x*)	18	(*xv*)	17
(*xi*)	19	(*xvi*)	18

The samples from trees (*vii*) to (*ix*) were collected by Australian Newsprint Mills, Ltd., from their forests in southern Tasmania, whereas those from trees (*x*) to (*xvi*) were collected with the help of the Forests Commission of Victoria from Victorian forests.

(f) Eucalyptus diversicolor *F. Muell.* Blocks were removed, as described under (c) and (e), from the normal wood, collected by D. Cullity of Westralian Plywoods Pty., Ltd., of a 300-yr.-old tree (*xvii*) grown in western Australia.

Procedures

(1) *Microtome Sections.* All transverse and radial sections were cut from fresh blocks of wood to a thickness of 20 and 60 μ (or 80 μ), respectively; they were kept immersed in water (plus layer of toluene) at 6°C. until required for use.

(2) *Acidity of Wood Extracts.* Thin shavings of wood were planned in a radial direction from the small blocks of wood. Fresh shavings (3 g.) were soaked in water (25 ml.) for 24 hr. at room temperature and the liquor removed by filtration from the shavings. Then the pH of the liquor was determined. In some cases the extracts were titrated, potentiometrically, to pH 8.5 using dilute aqueous sodium hydroxide solution.

(3) *Staining Techniques.* In the case of safranin and light green, a solution of safranin 0 (2 g. per 250 ml. water) was added to the transverse section on a glass slide; the slide was heated over a spirit lamp to *ca.* 90°C. and the section was washed with ethanol (50%); then a solution of light-green SF yellowish (1 g. per 100 ml. of 90% ethanol) was applied to the section; after 2 to $2^1/_2$ min. the section was washed successively with ethanol (90%), ethanol (99%), and xylene. It was then mounted in Canada balsam.

In the case of staining with ruthenium red, a solution (0.02 g. ruthenium red per 100 ml. water) was added to the section; after 10 min. it was washed in water and mounted in glycerin jelly. All mounted sections were stored in the dark.

(4) *Mechanical Treatments.* A "M.S.E." homogenizer, vortex beaker (100 ml.) and the appropriate blending assembly were used. The bakelite container, for the vortex beaker, was tapped so that cooling water could be circulated during each treatment. Normally, for each replicate, two radial sections were defibrated in water (50 ml.), using a homogenizer speed of 8500 r.p.m. For comparative tests the sections were defibrated for the same period of time.

(5) *Degree of Fiber Separation.* A portion of the pulp suspension from the defibration treatment was transferred in a wide-mouthed pipet to a glass slide. The slide was placed in a projection microscope, which magnified the field 100 times. The percentage ratio of free fibers to those both free and attached was reported as "fiber separation, per cent." A total of 100 to 200 fibers was counted for each replicate used in the determination.

(6) *Partially Delignified Wood.* In general 12 sections were heated with water (50 ml.), glacial acetic acid (0.15) ml.), and sodium chlorite (0.5 g.) at 72° ± 0.5°C. for 1 hr.; if additional treatment was required, the above quantities of acetic acid and sodium chlorite were added at the end of each hourly period. After

the required period of treatment the sections were washed by the addition and decantation of water.

(7) *Hydrolysis with Unbuffered Reagents.* In all cases two sections were added to the reagent (10 ml.: 0.05 or 5% aq. sol. of NaOH; 0.05 or 6% aq. sol. of HCl) in conical flasks (100 ml.) at the desired temperature. When the reaction had proceeded for the required time, it was stopped by the addition of cold water (80 ml.). The sections were washed by alternate addition and decantation of water.

(8) *Hydrolysis with Buffered Reagents.* During initial experiments a buffer solution (pH 3.8), prepared according to the data of McIlvaine (*51*) as given by Clark (*52*), was used in the manner described above. Later experiments utilized buffer solutions at pH 3.5 (citric acid, sodium hydroxide) and at pH 10.5 (potassium dihydrogen phosphate, sodium hydroxide) prepared according to Britton (*53*). For each buffer treatment 12 samples each containing 30 radial sections (1 cm. wide by 1.5 cm. long) of wood were used. Buffer solution (90 ml.) at bath temperature was added to each sample which was heated in a water bath maintained at 72.5 ± 0.3°C. In the case of the pH 3.5 buffer, a sample was removed every fourth day; in the case of the 10.5 buffer a sample was removed every minute. The treated samples were washed free of hydrogen (or hydroxyl) ions by addition and decantation of water.

(9) *Lignin Estimation.* For wood the method used was essentially that of Mahood and Cable (*23*), except that 1 g. of wood was treated with 15 ml. of 72% H_2SO_4 for 2 hr. at 20°C. For partially delignified wood, the method of Halse was used (*54*).

(10) *Pentosan Estimation.* The method used was similar to that described by Dorée (*55*), except that thiobarbituric acid was employed instead of phloroglucinol as the precipitant (*56*).

(11) *O-Acetyl Determination.* Small samples of wood from the various blocks were comminuted in the Wiley mill to pass a 60-mesh sieve: the milled wood was washed free of acids and the *O*-acetyl content was determined by the Australian Microanalytical Service using the *p*-toluene sulfonic acid method of Freudenberg and co-workers (*57, 58, 59*) in the apparatus of Wiesenberger (*60*).

LITERATURE CITED

1. Stewart, C. M., Watson, A. J., and Dadswell, H. E., *Appita* 11: 112 (1958).
2. Jaeger, J. C. and Somerville, J. L., *Austral. Pulp Paper Ind. Tech. Assoc. Proc.* 3: 14 (1949).
3. Somerville, J. L. and Burkitt, J. S., *Austral. Pulp Paper Ind. Tech. Assoc. Proc.* 5: 146 (1951).
4. Bland, D. E., Hanson, E. A., Stewart, C. M., and Watson, A. J., *J. Coun. Sci. Ind. Res.* (*Austral.*) 20: 553 (1947).
5. Stewart, C. M., *Coun. Sci. Ind. Res.* (*Austral.*), *Div. For. Products*, Sub-Proj. C.6-2, Prog. Rept. No. 2 (1947).
6. Stewart, C. M., *Austral. Pulp Paper Ind. Tech. Assoc. Proc.* 8: 50 (1954).
7. Stewart, C. M., McPherson, J. A., and Frydman, L., *Austral. Pulp Paper Ind. Tech. Assoc. Proc.* 10: 298 (1956).
8. Watson, A. J. and Cohen, W. E., *Austral. Pulp Paper Ind. Tech. Assoc. Proc.* 5: 188 (1951).
9. Johansen, D. A., "Plant Microtechnique," New York, McGraw-Hill Book Co., 1940.
10. Sass, J. E., "Elements of Botanical Microtechnique," New York, McGraw-Hill Book Co., 1940.
11. Clarke, S. H., *Tropical Woods* No. 52: 1 (1937).
12. Dadswell, H. E. and Ellis, D. J., *J. Coun. Sci. Ind. Res.* (*Austral.*) 13: 129 (1940).
13. Harlow, W. M., *Paper Trade J.* 112: TS 33 (1941).
14. Wardrop, A. B. and Dadswell, H. E., *Austral. J. Bot.* 3: 177 (1955).
15. Kerr, T. and Bailey, I. W., *J. Arnold Arboretum* 15: 327 (1934).
16. Joslyn, M. A. and Phaff, H. J., *Wallerstein Lab. Commun.* 10: 39 (1947).
17. Wardrop, A. B. Unpublished observations.
18. Abrams, A., *Ind. Eng. Chem.* 13: 786 (1921).
19. Wardrop, A. B. Unpublished observations.
20. Mackney, A. W., *J. Coun. Sci. Ind. Res.* (*Austral.*) 13: 115 (1940).
21. Schwalbe, C. G. and Becker, E., *Z. angew. Chem.* 32: 229 (1919).
22. Schorger, A. W., *Ind. Eng. Chem.* 9: 556 (1917).
23. Mahood, S. A. and Cable, D. E., *Ind. Eng. Chem.* 14: 933 (1922).
24. Ritter, G. J. and Fleck, L. C., *Ind. Eng. Chem.* 14: 1050 (1922); 15: 1055 (1923); 18: 608 (1926).
25. Timell, T. E., *Svensk Papperstidn.* 60: 762 (1957).
26. Tang, Y. C., *Cellulosechemie* 16: 90 (1935).
27. Stewart, C. M., *Nature* 186: 374 (1960).
28. Hägglund, E., Lindberg, B., and McPherson, J., *Acta Chem. Scand.* 10: 1160 (1956).
29. Bouveng, H. O., Garegg, P. J., and Lindberg, B., *Chem. and Ind.* No. 52: 1727 (1958).
30. Anonymous, "D.S.I.R. Forest Products Research, 1958," London, p. 42, H.M. Stationery Office, 1959.
31. Chattaway, M. M., *Austral. Forestry* 16: 25 (1952); and personal communication.
32. Spurr, S. H. and Hyvärinen, M. J., *Bot. Rev.* 20: 561 (1954).
33. Stewart, C. M., *Tappi* 40: 244 (1957).
34. Watson, A. J., Dadswell, H. E., and Stewart, C. M., *Appita* 11: 145 (1958).
35. Cohen, W. E. and Harris, E. E., *Ind. Eng. Chem.* (*Anal. Ed.*) 9: 234 (1937).
36. Asunmaa, S. and Lange, P. W., *Svensk Papperstidn.* 55: 217 (1952).
37. Lange, P. W., *Svensk Papperstidn.* 57: 525 (1954).
38. Sarkar, P. B., Chatterjee, H., and Mazumdar, A. K., *J. Text. Inst.* 38: 318 (1947).
39. Sarkar, P. B., Chatterjee, H., Mazumdar, A. K., and Pal, K. B., *J. Text. Inst.* 39: 1 (1948).
40. Foster, D. H., Schwerin, G., and Cohen, W. E., *Austral. J. Sci. Res.* A3: 504 (1950).
41. Stewart, C. M., Amos, G. L., and Harvey, L. J., *Austral. J. Biol. Sci.* 6: 21 (1953).
42. Taylor, E. W., Fowler, W. F., McGee, P. A., and Kenyon, W. O., *J. Amer. Chem. Soc.* 69: 342 (1947).
43. Anderson, E., Seigle, L. W., Krznarich, P. W., Richards, L., and Marteny, W. W., *J. Biol. Chem.* 121: 165 (1937).
44. Neubauer, L. G. and Purves, C. B., *Canad. J. Chem.* 35: 388 (1957).
45. Stewart, C. M. and Foster, D. H., *Austral. J. Chem.* 6: 431 (1953).
46. Brauns, F. E. and Yirak, J. J., *Paper Trade J.* 125: TS55 (1947).
47. Stewart, C. M. Unpublished observations.
48. Jacobs, M. R., *C'wealth For. Bur.* (*Austral.*) *Bull.* 28 (1945).
49. Boyd, J. D., *Austral. J. Sci. Res.* B3: 294 (1950).

49(a). Dadswell, H. E. and Langlands, I., *J. Coun. Sci. Ind. Res* (*Austral.*) 7: 190 (1934).

50. Wardrop, A. B. and Dadswell, H. E., *Coun. Sci. Ind. Res.* (*Austral.*) *Bull.* 221: Pt. 5 (1947).
51. McIlvaine, T. C., *J. Biol. Chem.* 49: 183 (1921).
52. Clark, W. M., "The Determination of Hydrogen Ions," 2nd ed., Baltimore, Williams and Wilkins Co., 1922.
53. Britton, H. T. S., "Hydrogen Ions; Their Determination and Importance in Pure and Industrial Chemistry," Vol. I, London, Chapman and Hall, Ltd., 1955.
54. Halse, O. M., in Siebel, E., "Handbuch der Werkstoffprüfung," 2nd ed., Berlin, Springer-Verlag, 1953.
55. Dorée, C., "The Methods of Cellulose Chemistry Including Methods for the Investigation of Substances Associated with Cellulose in Plant Tissues," 2nd ed., London, Chapman and Hall, Ltd., 1950.
56. Mackney, A. W. and Reynolds, T. M., *J. Coun. Sci. Ind. Res.* (*Austral.*) 11: 333 (1938).
57. Freudenberg, K. and Harder, M., *Ann.* 433: 230 (1923).
58. Freudenberg, K. and Weber, E., *Z. angew. Chem.* 38: 280 (1925).
59. Freudenberg, K. and Soff, K., *Ann.* 494: 68 (1932).
60. Wiesenberger, E., *Mikrochemie* 33: 51 (1948).

Received May 12, 1961.

Presented at the Tenth Pacific Science Congress, of the Pacific Science Association, held at the University of Hawaii, Honolulu, Aug. 21 to Sept. 6, 1961. Sponsored by the National Academy of Sciences, Washington, D. C., and Bernice P. Bishop Museum, Honolulu, with the cooperation of the University of Hawaii.

The authors wish to thank Miss Maiga Vitolins, Miss Glenys Chong, Miss Mary Mortensen, and Miss Margaret Williams for cutting and staining the sections and for determining the percentages of free fibers in many of the samples and for general help with the work.

The Effect of Laminating Techniques on the Corrosion Resistance of Reinforced Plastic Paper Mill Equipment

S. S. FEUER and A. F. TORRES

The effect of laminate variables on the corrosion resistance of glass-reinforced plastic structures has been studied. Corrosion tests based upon retention of strength in various corrosive solutions over a period of three months were carried out. It was found that the most important factors were the glass/resin ratio and the type of resin employed. Higher resin ratios and the use of a bisphenol-A polyester resin gave the best results. Techniques involved in the preparation of laminates were also studied. The need for a "resin-rich" surface layer, utilizing surfacing mat, to obtain maximum corrosion resistance at the surface to be exposed to the corrosive fumes or solutions is emphasized. Methods for evaluating laminate quality are described.

THE PAPER industry is showing a growing interest in reinforced plastic equipment to combat the high cost of corrosion. Plastic materials such as the specialty polyesters (Atlac 382 based on bisphenol-A, for example) will resist many of the corrosive fumes and solutions ordinarily employed in paper mills: acids, alkalies, sulfur dioxide, hypochlorites, salts, many solvents, chlorine dioxide, and bleach solutions. Reinforced plastic fabricating lends itself to all sizes and configurations, and the equipment is light in weight, easy to install, and requires little or no maintenance. Reinforced bisphenol-A [2,2′-bis (hydroxyphenyl)-propane] polyester, for example, has found a natural niche in the bleach plant, where equipment such as hoods, washers and accessories, fans, ducts, piping, vent stacks, exhaust fumes, mixers, and covers for pre-retention units must withstand the effects of chlorine, chlorine dioxide, and hypochlorite fumes and solutions.

Length of service life and degree of maintenance required will depend upon three basic factors: (1) type of plastic and reinforcing fibers employed; (2) equipment design; and (3) quality of the fiber-plastic laminate. It is becoming increasingly understood by paper mill equipment specifiers that selection of the plastic for an application should be based on the specific corrosives and temperatures encountered in that application. Also, more and more information on the proper design of reinforced plastic equipment is becoming available. The importance of laminate quality, however, has been largely neglected, although this factor is intimately related to equipment performance. Knowledge of the effects of laminating techniques on equipment service life will help the specifier in his quest to provide equipment that will live up to expectations.

Recent studies at Atlas Chemical Industries, Inc. have shown that even when the most resistant of polyester resins is used in the manufacture of units such as hoods, tanks, ducts, scrubbers, or stacks, improper laminating techniques may cause a premature end to the working life of the equipment. The paper plant engineer will find it helpful to study comparative tests, such as those performed by Atlas, as an aid both in selecting the proper resin for specific conditions and in avoiding the pitfalls of poor fabrication.

S. S. FEUER and A. F. TORRES, Atlas Chemical Industries, Inc. Wilmington, Del.

EFFECT OF LAMINATE COMPONENTS

The structure of the laminate (the proportion of resin, type of reinforcing fiber, filler, etc.) plays an important role in determining corrosion resistance. Equipment built up by hand lay-up should be approximately 25% glass-75% resin. Laminates formed by matched metal die molding will run approximately 30% to 33% glass. The effect of too high a glass content can be seen from a series of corrosion tests recently completed. Table I shows that at the end of three months, laminates made up of 67% resin and 33% glass outperformed 50% resin-50% glass samples in most of the corrosive solutions used. In addition to their superior short-term corrosion resistance, the 67%-resin test samples showed a leveling-off of flexural strength in most of the solutions (Fig. 1). This leveling-off is of extreme importance because it results in considerably longer service life than the extrapolated short-term data would suggest.

The superior chemical resistance of the 67%-resin laminate stems from its higher resin content. Chemical inertness is imparted primarily by the resin. The glass cloth or mat is incorporated primarily to add strength to the structure. Glass fiber used in the Atlas tests were of the borosilicate type, a chemically resistant type of glass generally used by fabricators of corrosion-resistant reinforced-plastic equipment.

Fiber Type

The corrosion resistance of a reinforced polyester structure is also influenced significantly by the type of fiber in the surfacing mat, as shown in Fig. 2. Experiments showed that of the three materials tested, a Dacron-surfacing mat retained the greatest degree of flexural strength in acid and equalled the performance of a glass-surfacing mat in alkaline solutions, distilled water, and sodium hypochlorite. An Orlon-surfacing mat proved to be inferior to both the Dacron- and the glass-surface laminate in most of the corrosive solutions. Although not evaluated in this test series, Dynel has been reported to show excellent results, particularly as a surfacing mat in alkaline solutions.

EFFECT OF LAMINATE PREPARATION TECHNIQUES

The effects of poor laminate preparation on corrosion resistance were also studied. Test samples of reinforced polyester laminates were made up in a press without the protection of a surfacing mat, a

Table I. Room Temperature Cure Laminates 50/50 vs. 67/33 Resin[a]/Glass—"C" Glass Veil

		Flexural strength, p.s.i.	*Retention, %*	*Modulus of elasticity p.s.i.*	*Retention, %*	*Barcol hardness*
Initial	50/50	39,000		1.37×10^6		55–65
	67/33	26,488		0.94		38–45
25% H_2SO_4	50/50	17,610	45	0.94	68	32–40
	67/33	20,800	78	0.91	96	47–49
5% NaOH	50/50	11,080	28	0.88	64	30–37
	67/33	13,900	52	0.77	81	34–41
5% Electrasol[b]	50/50	27,250	70	1.36	100	40–50
	67/33	13,800	52	0.77	81	37–43
5% HNO_3	50/50	22,160	57	0.98	71	45–50
	67/33	12,700	47	0.70	74	39–48
25% Acetic acid	50/50	24,000	61	0.93	68	42–50
	67/33	19,400	73	0.90	95	39–43
15% HCl	50/50	12,930	33	0.75	55	30–38
	67/33	19,000	71	0.90	95	38–40
5.25% $NaHClO_3$	50/50	26,200	67	0.61	44	54–60
	67/33	25,300	95	0.97	103	42–46
Distilled water	50/50	27,350	70	1.25	91	50–54
	67/33	20,800	78	0.94	100	47–54

[a] Bisphenol-A polyester.
[b] A nonionic dishwashing detergent, Economics Laboratory, St. Paul, Minn.

vital component for corrosion resistance. The glass fiber was purposely not wet-out properly, (individual fibers not thoroughly covered with resin), and glass fiber bundles were prominent at the surface of the structure.

Table II shows that the poorly wet-out unprotected laminates had markedly inferior corrosion resistance properties in all test solutions. Although the type of polyester resin used exerted a powerful influence on chemical resistance, the test showed that service life of equipment with a poorly laminated structure will be reduced to as little as one fifth of the expected life. The results clearly show the importance of preparing a well wet-out laminate with a resin-rich protective surface layer to obtain maximum corrosion resistance.

LAMINATING TECHNIQUES FOR MAXIMUM CORROSION RESISTANCE

Reinforced plastic paper-mill equipment should have a uniform laminate thickness and a uniform glass-to-resin ratio, without areas that are excessively

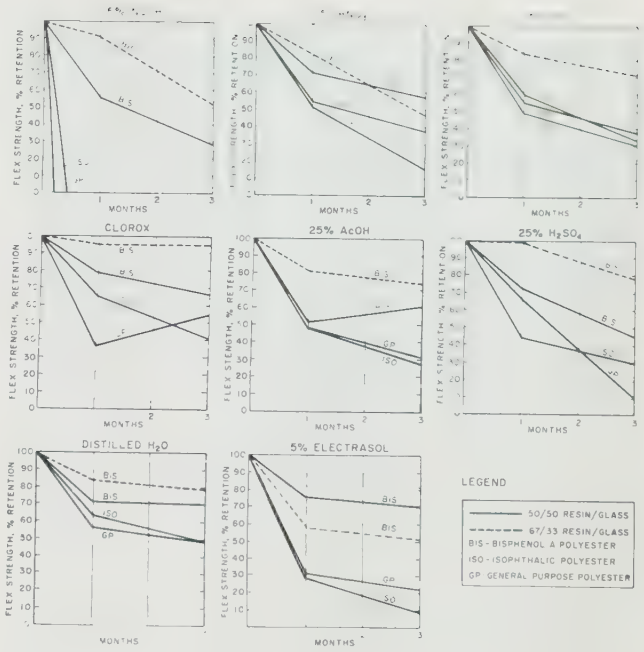


Fig. 1. Flexural strength retention of hand lay-up laminates in corrosive solutions @210°F.

All samples prepared with "C" glass veil overlay and cured at room temperature

resin-rich or poorly wetted out. The laminate should be dense, without visible voids or dry spots, or a cracked or crazed surface. A minimum of air bubbles and other irregularities is essential for a well-prepared laminate.

A smooth inner surface protected by a resin-rich coating will contribute to good chemical resistance. The outer surface should also be smooth, without exposed glass fiber bundles. All exposed glass fibers, such as those exposed by cutting of a section, must be protected by coating with resin.

Table II. Corrosion Resistance of Poorly Wet-Out Glass-Polyester Laminates

	Bisphenol-A				*General purpose*				*Isophthalic*			
	Flexural strength, p.s.i.	*Retention, %*	*Modulus of elasticity, p.s.i.*	*Retention, %*	*Flexural strength, p.s.i.*	*Retention, %*	*Modulus of elasticity, p.s.i.*	*Retention, %*	*Flexural strength, p.s.i.*	*Retention, %*	*Modulus of elasticity, p.s.i.*	*Retention, %*
Initial	26,460		0.98×10^6		26,210		1.09×10^6		29,249		1.07×10^6	
At Room Temperature												
25% H_2SO_4												
1 wk.	19,900	75	0.85	86	21,958	83	0.92	84	25,440	86	1.08	100
1 mo.	16,600	62	0.71	72	15,900	60	0.74	67	20,800	71	0.96	89
3 mos.	16,100	60	0.63	64	17,020	64	0.68	62	18,130	61	0.78	72
5% NaOH												
1 wk.	15,300	57	0.90	91	14,448	55	0.77	70	19,882	67	0.98	91
1 mo.	11,300	42	0.87	88	6,300	24	0.58	53	12,400	42	0.93	86
3 mos.	13,150	49	0.75	76	0	0	0	0	6,000	20	0.77	71
Distilled water												
1 wk.	22,300	84	0.96	94	19,637	74	0.85	77	24,414	83	1.04	97
1 mo.	20,200	76	1.02	104	21,198	80	0.90	82	23,000	78	1.10	102
3 mos.	20,100	75	0.95	96	20,330	77	0.92	84	21,710	74	1.01	94
210°F. Exposure												
25% H_2SO_4												
1 wk.	12,906	48	0.81	82	4,581	17	0.21	19	13,059	44	0.59	55
1 mo.	5,800	21	0.37	37	410	1.5	...	0	5,800	19	0.48	44
3 mos.	3,100	11	0.42	42	507	2.0	...	0	3,100	10	0.40	42
5% NaOH												
1 wk.	15,218	57	0.79	80	deteriorated in less than 1 wk.				deteriorated in less than 2 wks.			
1 mo.	9,650	36	0.79	80	0	0	0	0	0	0	0	0
3 mos.	4,200	15	0.65	66	0	0	0	0	0	0	0	0
Distilled water												
1 wk.	15,900	60	0.82	83	12,995	60	0.65	59	19,678	67	0.95	88
1 mo.	11,600	43	0.74	75	6,149	23	0.46	42	13,000	44	0.86	80
3 mos.	8,750	33	0.68	69	4,300	16	0.37	33	8,200	28	0.72	67

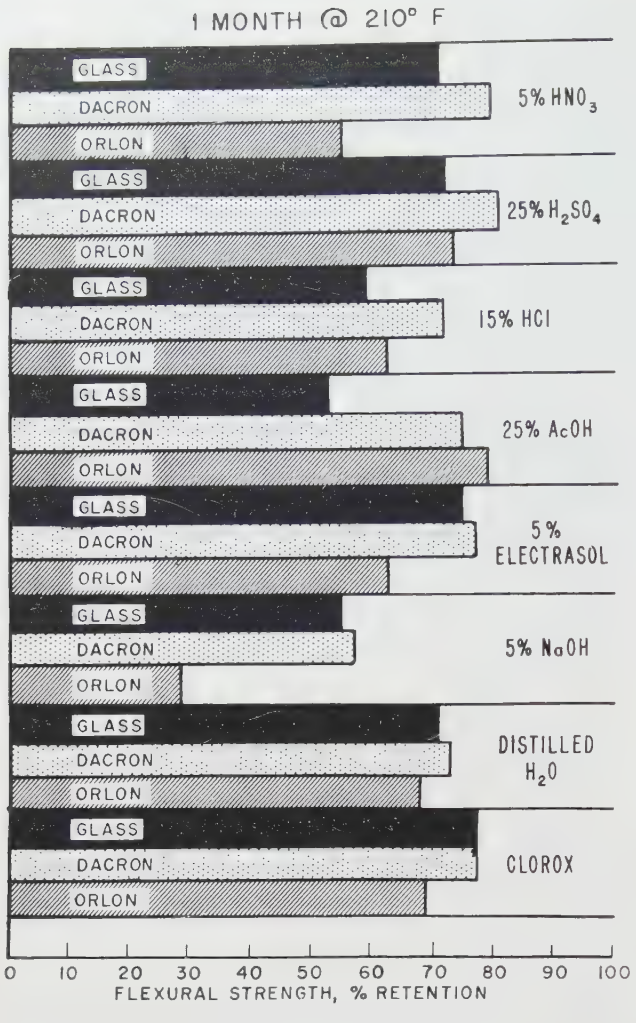


Fig. 2. Effects of various surfacing fibers on corrosion resistance of laminates

Bisphenol-A polyester, 50/50 resin/reinforcing fiber used in all laminates

Protection of the Laminate

Resin-Rich Layer. Building up a resin-rich layer is the fabricator's first step in preparing the surface that will be exposed to corrosive fumes or liquids. This high-resin-content layer (generally built up on glass surfacing mat or "veil") is vital for protecting the reinforcing fibers within the laminate. A smooth, glossy surface will increase the resistance to chemical attack.

The fabricator may use a thixotropic agent such as colloidal silica in the resin, if vertical surfaces are involved. Incorporation of 1 to 2% of this material into the resin-styrene mix prevents the resin from sagging or running down the surface of the mold (Fig. 3).

Surfacing Mat. A surfacing veil or mat placed in the initial corrosion-resistant resin-rich layer is essential for protecting the remainder of the laminate. The surfacing material isolates the structural elements of the laminate, and prevents bundles of reinforcing fibers in the laminate interior from coming to the surface. Therefore, the layer of surfacing veil or mat and resin should be smooth and without surface irregularities.

Although glass is the principal reinforcing fiber used in polyester laminates, synthetic fibers such as Orlon, Dynel, and Dacron are sometimes useful as surfacing

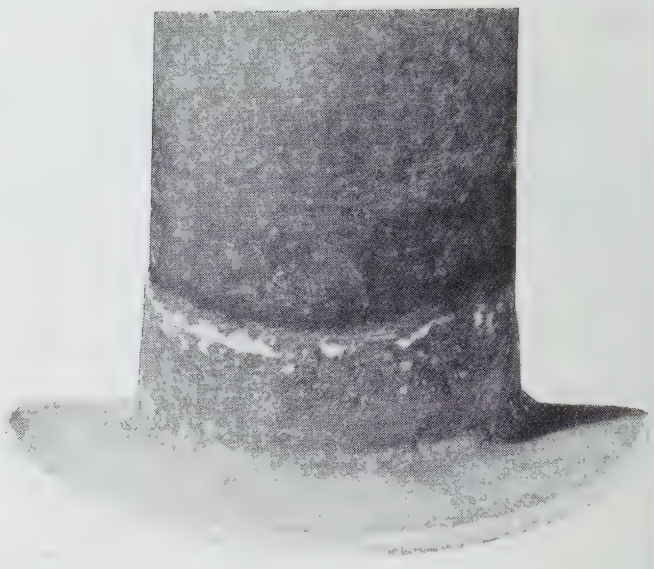


Fig. 3. The bulge near the area where the flange is joined to the reinforced polyester pipe was caused by "resin sag"

material, particularly in applications involving fluoride fumes, which will attack glass fibers. In such an application, the synthetic-fiber surface veil will protect the glass fibers in the laminate interior. Polyester resins, particularly the bisphenol-A type, will resist attack by fluorides when properly used, but a synthetic surfacing mat is sometimes necessary.

The surface mat appears to contribute more to overall structural strength than may be expected. This factor should be considered when designing and specifying laminates containing synthetic-fiber surfacing mats, which are lower in strength than similar laminates containing glass.

Interior Laminate Construction

The resin-rich layer and surfacing mat are generally followed by two alternate layers of chopped-strand borosilicate glass, rather than lime glass, reinforcing mat and resin (Fig. 4). Specifications should call for a mat weight of at least $1^1/_2$ oz. The binder in the mat should be resin-soluble to allow the glass mat to be formed without springback. Specifications should then call for subsequent layers of glass mat, cloth, or woven roving to satisfy weight and strength requirements.

The Uniform Distribution of Resin. The resin applied to the various layers of reinforcing mat or cloth must be distributed evenly. The resin is usually spread with a brush or roller over and into the reinforcing material. However, some fabricators are now turning to spraying because it offers greater speed and reduces labor costs.

The resin is distributed on and into the mat with a

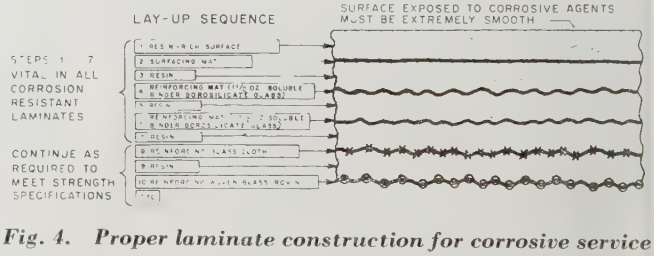

LAY-UP SEQUENCE
SURFACE EXPOSED TO CORROSIVE AGENTS MUST BE EXTREMELY SMOOTH
STEPS 1 7 VITAL IN ALL CORROSION RESISTANT LAMINATES
CONTINUE AS REQUIRED TO MEET STRENGTH SPECIFICATIONS
1 RESIN-RICH SURFACE
2 SURFACING MAT
3 RESIN
4 REINFORCING MAT TYP 1½ OZ. SOLUBLE BINDER BOROSILICATE GLASS
5 RESIN
6 REINFORCING MAT TYP 1½ OZ. SOLUBLE BINDER BOROSILICATE GLASS
7 RESIN
8 REINFORCING GLASS CLOTH
9 RESIN
10 REINFORCING GLASS ROVING
ETC.

Fig. 4. Proper laminate construction for corrosive service

Thicknesses of resin layers have been exaggerated for clarity

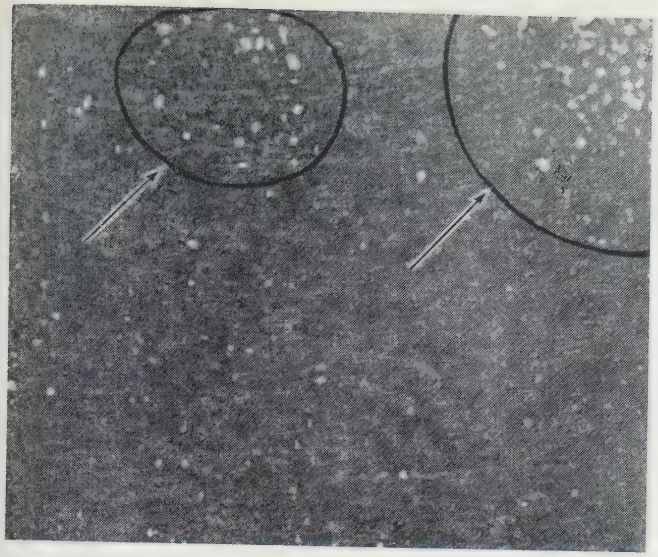


Fig. 5. Visual examination of a laminate showing excessive air entrappment in the resin-rich surface

metal, plastic, or cloth-covered roller. Proper rolling will contribute to thoroughly wet-out fibers, without pin holes in the resin surface, and deep resin penetration in overlapping areas. Rolling also eliminates most of the air present in the mat.

Overlapping areas of mat or cloth require special care to cover each layer with resin individually, and this operation should be covered in the specification. Whereas a poorly constructed overlapping section will weaken the mechanical strength of the entire structure and diminish corrosion resistance, a proper joint will enhance the working life of the laminate. For cloth or mat, an overlap of at least 2 in. is recommended. Lapped sections of adjacent layers should be staggered for maximum strength.

The Effect of Curing Methods. The method of curing the resin, a technique based on the experience of the fabricator, will exert a definite influence on both the strength of the laminate and its corrosion resistance. The curing system, usually benzoyl peroxide and dimethylaniline, functions basically to begin the exothermic reaction. A thin section requires more catalyst (benzoyl peroxide) because of rapid heat losses through convection and radiation. Thick sections, on the other hand, generally need less catalyst because a much higher exothermic temperature is developed in the structure.

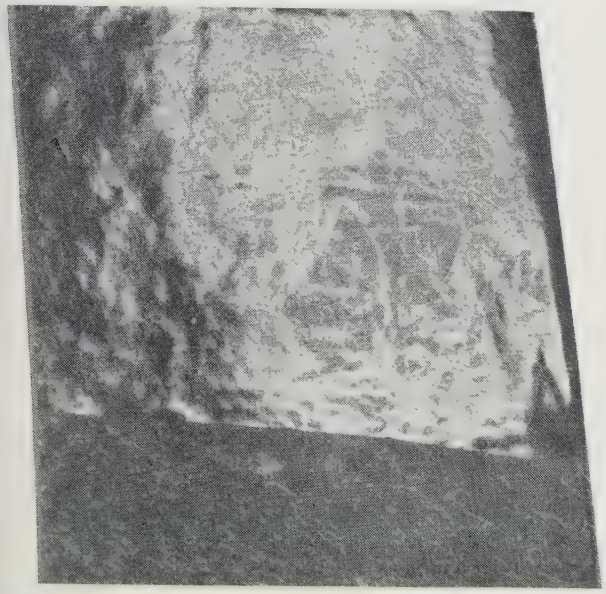


Fig. 6. Example of a well-prepared laminate (bottom) having a uniform, smooth resin-rich surface and (top), exposed fibers and an uneven, rough surface

Fig. 7. Example showing a prominence of reinforcing fiber bundles on the surface of the piece

An excessive amount of catalyst will bring about a too rapid cure, with resulting internal stresses. Surface cracking (crazing) is prime evidence that internal stresses have been set up by excessive internal heat due to improper cure. These cracks are cause for rejection of the piece. Brought about by unequal expansion of the surface and interior of the laminate, they will allow the entrance of corrosive fumes or liquids and hasten deterioration of the equipment.

TESTS FOR LAMINATE QUALITY

Visual examination provides one of the most simple and effective ways to judge the soundness of a laminate. By placing a light behind the wall or section of an unpigmented structure, the engineer can judge the uniformity of the laminate and detect excessive air, dry spots, internal cracking or other conditions indicating possible weaknesses in the structure (Fig. 5).

Surface condition is another indication of laminate construction. A smooth, true surface is generally a sign of a well made, uniformly cured laminate. If exposed fibers exist on the surface, there is a rupture in the protective gel coat which is vital to corrosion-resistance (Fig. 6). Exposed fiber bundles also indicate the likelihood that a surfacing mat is absent (Fig. 7).

Industrial specifications often call for cutting a section of the fabricated piece (overage of length, manhole, etc.) for testing. The resulting cross-section

will reveal the depth of the surface layer and shape and conformity of the laminate. Stressed areas often will be seen immediately in the form of internal cracks. The cross-section will also show the bond between layers and degree of wet-out of the fibers as well as the position of the surfacing mat and the thickness of the protective resin-rich layer.

Another test is Barcol* hardness. This test is useful only for measuring the relative hardness of pieces fabricated from a single type of resin. Results are meaningless when comparing different resins because each polyester will have its own inherent hardness. If the Barcol hardness of a laminate falls short of the average ratings found in well-cured structures of the same resin and construction, the paper mill engineer should immediately suspect an incomplete cure, resulting in poor corrosion resistance.

Received May 19, 1961.

*A standard method of hardness measurement based on equipment manufactured by Barber-Coleman Co., Rockford, Ill., U.S. Pat. No. 2,372,622.

The Use of Polyvinyl Alcohol as a Color Coating Adhesive

GEORGE P. COLGAN and JOSEPH J. LATIMER

The properties of polyvinyl alcohol coating colors and coated paper were studied. The colors were found to exhibit rheological properties typical, depending on solids content, of Newtonian and shear-thinning fluids; and solids–viscosity relationships similar, in view of low binder requirement, to colors prepared from the more typical commercial binders. The adhesive strength was found to be approximately three times that of casein or soy protein and four times that of starch. The optical properties of clay coatings in general were found to be largely a function of total adhesive content, and, again because of their low binder levels, polyvinyl alcohol coatings displayed greater ease of calenderability and measurably higher brightness and opacity. With sufficient heat input it was found possible to prepare highly water-resistant coatings. The oil and grease resistance of polyvinyl alcohol was found to be outstanding.

Some years ago Air Reduction Co. undertook a market survey to determine potential areas where polyvinyl alcohol (PVA) could be used. Special attention was given to surveying the paper industry. It was learned that a few mills were using PVA as a size, as a laminating adhesive, and as a grease-barrier coating, and that it had been considered, at one time or another, as a clay coating adhesive.

The use of a borax-PVA sizing technique, a process which has been in existence for some time (*1*) but which has only recently received widespread acceptance, has much increased the consumption of PVA as a size in the paper industry. Its consumption as a laminating adhesive has similarly increased, while its use as a barrier coating is still in a growth stage. The use of PVA as a coating color adhesive is the subject of the present paper.

Although PVA as a binder has a high adhesive strength, several factors, the most outstanding of which was cost, precluded any serious developmental effort with this material for products having other than specialty uses. With greater availability the price of PVA has been reduced considerably and the market potential for PVA in the paper industry as a coatings adhesive appeared to be large. Consequently an investigation was undertaken to determine just how suitable PVA is for this application.

It should be pointed out that PVA can mean many things: first, although the letters "PVA" are used by most authors as the abbreviation for polyvinyl alcohol, many others—particularly in the paint industry—use this same abbreviation for polyvinyl acetate. The present authors use PVA for polyvinyl alcohol and PVAc for polyvinyl acetate. Second, the products themselves, polyvinyl alcohol and polyvinyl acetate, are sometimes confused. An attempt will be made in the discussion below to differentiate these materials. Third, PVA is not one single product but a family of products which vary both in molecular weight and in composition.

Figure 1 shows the difference between PVA and PVAc. It can be seen that PVA is made by the hydrolysis—more correctly alcoholysis—of PVAc. The hydrolysis may be stopped at any point to yield polymers having properties distinctly different from the original PVAc and different from one another. Arbitrarily, any product that is more than 50% hydrolyzed is called polyvinyl alcohol. Five different degree-of-hydrolysis grades of PVA are available commercially. They are listed in Table I.

Most of the different degree-of-hydrolysis grades are available in several different molecular weights. Essentially, high-, medium-, and low-molecular- weight products are available. The molecular weight is controlled by the polymerization step in the preparation of the polyvinyl acetate. The higher molecular weight

Table I. Commercial Grades of Polyvinyl Alcohol

Degree of hydrolysis, %		*Viscosity, cp.*[a]	
Super hydrolyzed	99.7–100	High	60
		Med.	30
Fully hydrolyzed	99–100	Very high	150
		High	60
			50
		Med.	30
			25
			15
		Low	5
Fully hydrolyzed (nongelling)	96–99	High	60
			50
		Med.	30
			25
Partially hydrolyzed	86–89	Very high	100
		High	40
		Med.	23
		Low	5
Partially hydrolyzed	73–77	Low	3
		Low	2

[a] 4% solids aqueous solutions at 20°C.
Two specialty, acid-hydrolyzed products-approximately 99% hydrolyzed and of medium molecular weight were not included.

George P. Colgan, Supervisor of Paper Technical Service, and Joseph J. Latimer, Section Head, Development Laboratory, Air Reduction Chemical and Carbide Co., Bound Brook, N. J.

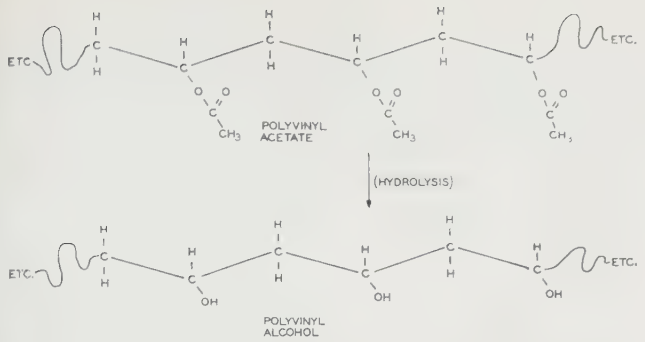


Fig. 1. Polyvinyl acetate and polyvinyl alcohol

types, of course, produce solutions that are more viscous than those of lower molecular weight. For convenience, the various products having different molecular weights are characterized by the viscosity of their 4% aqueous solutions. Hence, a PVA that yields a viscosity of 60 cp. is commonly called a "sixty centipoise grade," and so forth.

Table I shows the viscosity grades that are now marketed. It should be mentioned that not all suppliers produce all the grades listed nor are the same grades of the various manufacturers entirely equivalent. It will be noted in the table that the terminology employed in designating the various grades is not ideally systematic, but has evolved with time and usage.

Our studies have indicated that for coating color work the PVA should be at least fully hydrolyzed and should have a medium molecular weight. The reasons for this conclusion will become evident in the discussion which follows.

In evaluating PVA as a coating adhesive a great part of our effort has been concentrated on the areas of rheology, adhesive strength, optical properties, and water, oil and grease resistance. Each of these subjects will be treated separately.

RHEOLOGY

Our survey indicated that solutions of synthetic, water-soluble polymers were considered, in general, too viscous. Probably this idea originated from experiences with the very high-molecular-weight cellulosics.

Air Reduction Co. had for sometime been interested in a superhydrolyzed grade of PVA which was being manufactured in Japan for use in textile fibers. Hence, our early paper-coating studies were carried out with this material. Our subsequent work showed that this was a product of choice for coating color use; its viscosity, in particular, was of a suitable order. This same product is now produced in this country as Vinol 125. Figure 2 shows viscosity data obtained with colors containing Vinol 125 as the binder.

Only predispersed clay, PVA, and water were present in the coating colors. The amount of binder used, (5 pt. to 100 pt. of clay) was that which in the dried coatings gave a critical wax number of anywhere from 5 to 8, depending on the choice of raw stock. The viscosities compare favorably with those of other typical commercial binders, keeping in mind, of course, the quantities of the latter that are required for this level of pick strength. For example, 50% solids colors containing typical coating grades of other resins at levels, in each case, that were found equivalent in

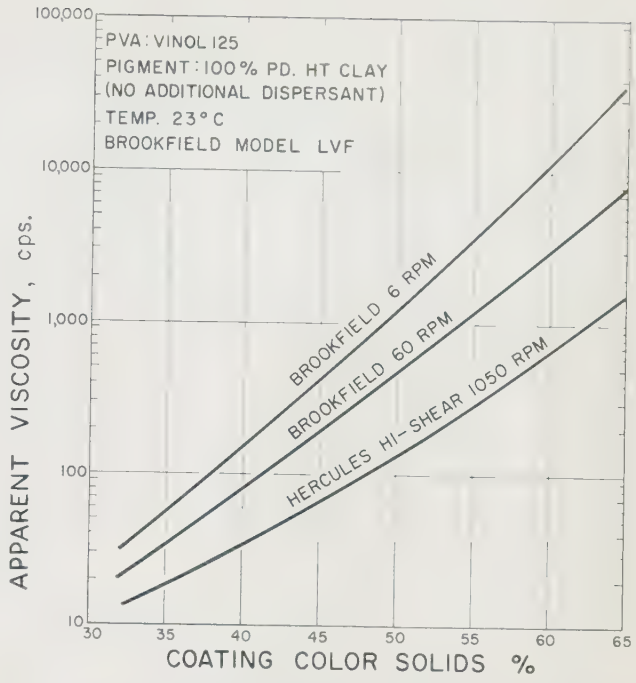


Fig. 2. Viscosity-solids relationships; 5 pt. super hydrolyzed PVA–100 pt. clay colors

strength to 5 pt. PVA displayed 60 r.p.m. viscosities as follows: casein (15 pt.) 10,000 cp.; soy protein (15 pt.) 7000 cp.; and starch (20 pt.) 1000 cp. The subject of relative adhesive strengths will be discussed below. The particular casein and soy protein employed were medium viscosity grades and the starch was a low viscosity product. Similar to other binders PVA can be combined with latex when even greater fluidity is desired.

Figure 3 shows how the viscosities of 7 pt. and 3 pt. PVA colors compare with the 5 pt. colors just shown. In this case Hercules high shear, 1050 r.p.m. viscosities are presented. A 50% solids color containing 13 pt. casein—which is still not the adhesive equivalent of 5 pt. PVA—yields a 230 cp. value on this same scale.

Figure 4 demonstrates the type of Hercules high shear rheograms that are obtained with PVA colors. As is the case with any other acceptable binder, the high solids colors become more fluid when sheared (shear-thinning); and, of course, at lower solids Newtonian flow properties are approached.

These data, we think, demonstrate that the flow properties of PVA colors are quite acceptable. Indeed, mill experience has proved this to be true.

PHYSICAL PROPERTIES

Adhesive Strength

Polyvinyl alcohol has been singled out by Casey (*2*), Mosher (*3*), and others (*4*) for its excellent adhesive strength.

The pick strengths of the medium (30 cp.) and high (60 cp.) molecular weight, fully hydrolyzed types of PVA are essentially equivalent, while the strength of the low-viscosity grade (5 cp.) is considerably inferior. This is demonstrated in Table II.

With regard to degree of hydrolysis, the pick strength of the higher hydrolyzed PVA is slightly superior to that of the partially hydrolyzed material. This can be seen Table III.

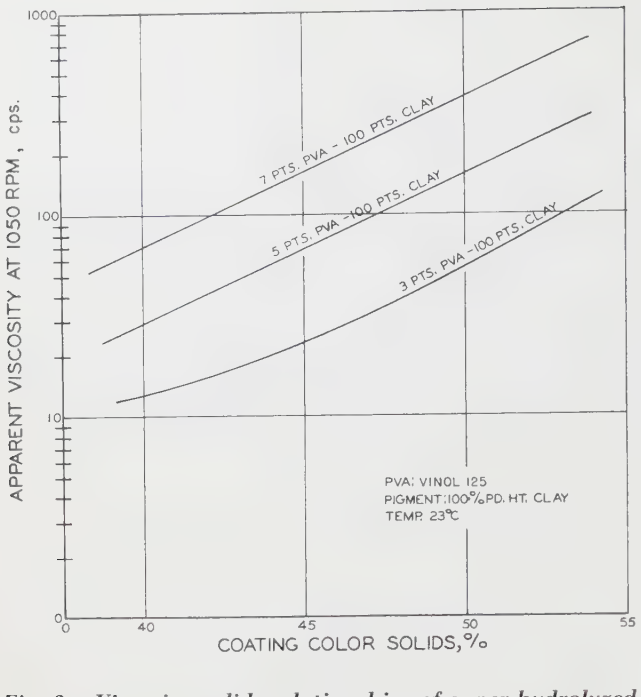


Fig. 3. Viscosity–solids relationships of super hydrolyzed PVA coating colors at various binder levels

Hercules High Shear

Wax pick becomes an unreliable measure with the partially hydrolyzed grades and is therefore not shown. Also, the values of Table II and III cannot be directly compared as different tack inks and somewhat different experimental conditions were involved.

For optimum strength, then, the PVA should be at least fully hydrolyzed, and at least of medium molecular weight. With consideration for fluidity the medium molecular weight is preferred to the high molecular weight type.

Figure 5 compares the pick strengths of superhydrolyzed, medium viscosity PVA, casein, soy protein, starch, and mixtures of the PVA, casein and soy protein, respectively, with butadiene-styrene latex, wherein $^1/_3$ of the binder was butadiene–styrene (B/S) resin.

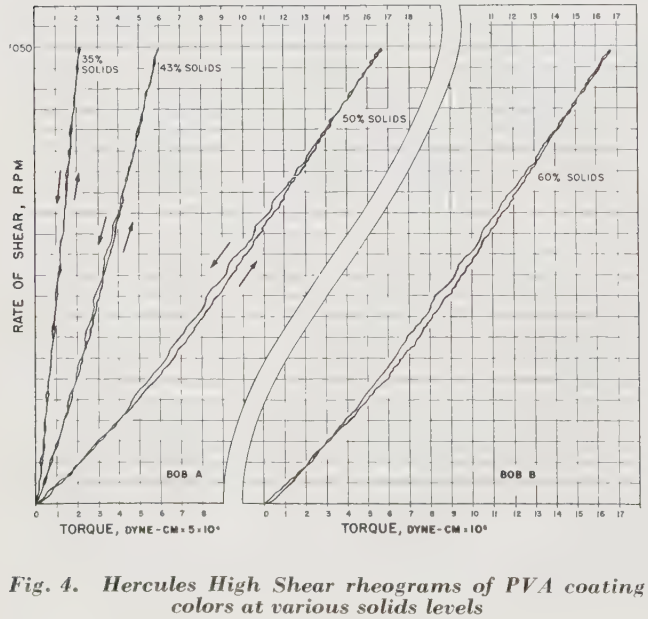


Fig. 4. Hercules High Shear rheograms of PVA coating colors at various solids levels

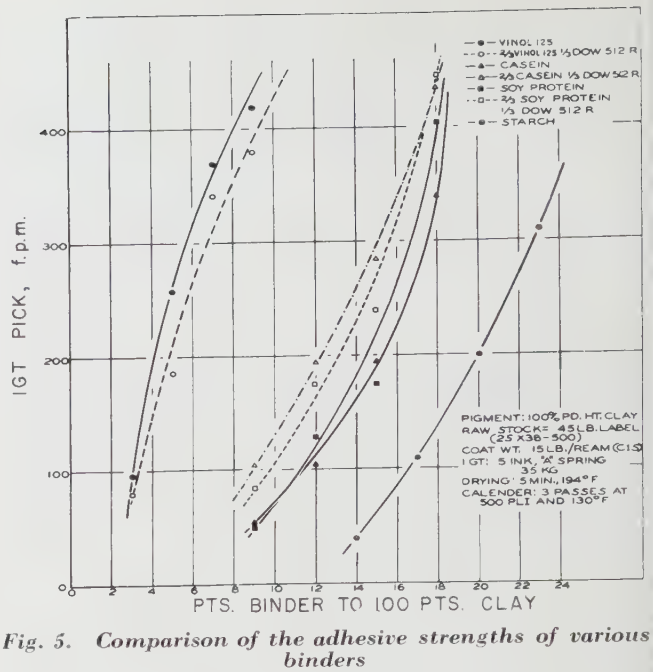


Fig. 5. Comparison of the adhesive strengths of various binders

At a binder level which is about adequate for offset printing, 5 pt. PVA are seen to be equivalent to 15–16 pt. of either casein or soy protein, 13–14 pt. of the casein–B/S and protein–B/S mixtures, and 20 pt. of starch.

It should be mentioned that the scale of the oridnate will shift up or down, depending on the raw stock used; but the relative strength relationships of the various binders should be roughly the same.

It can be seen that replacing a portion of the PVA with the less efficient B/S has not caused a very great loss of pick strength. In this and other studies we have found that up to about $^1/_3$ of the PVA can be replaced with either B/S or acrylic latex with little or no pick loss. It appears that some kind of synergism exists.

The relationships shown in Fig. 3 demonstrate that PVA is some three times more efficient than casein or soy protein with respect to adhesive strength. Obviously, then, PVA can be approximately three times greater in cost than these latter materials and still be economically competitive.

Table II. Polyvinyl Alcohol Viscosity Grade and Coating Strength

All fully hydrolyzed (99–100%) PVA

Viscosity grade, cp.	*IGT pick,[a] f.p.m.*	*Wax pick[b]*
Low (5)	<100	3A
Medium (30)	322	7A
High (60)	320	7A

[a] No. 8 IPI ink, "A" spring setting, 35 kg. load.
[b] Dennison critical wax no.

Table III. Polyvinyl Alcohol Degree of Hydrolysis and Coating Strength

All medium viscosity PVA

Degree of hydrolysis, %	*IGT pick,[a] f.p.m.*
86–89	403
98–99	418
99–100	422

[a] No. 6 IPI ink, "A" spring setting, 35 kg. load.

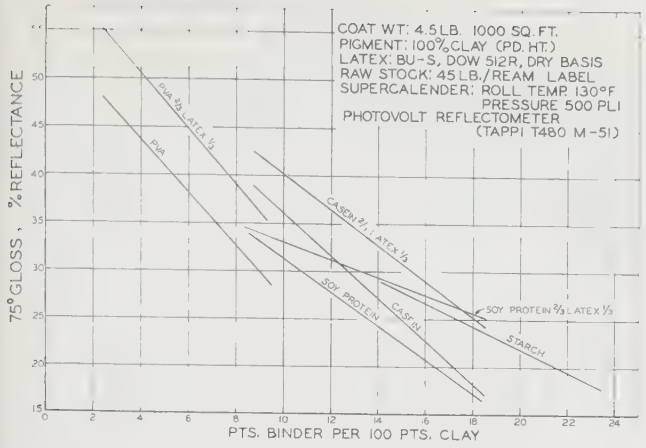


Fig. 6. Gloss as a function of binder content

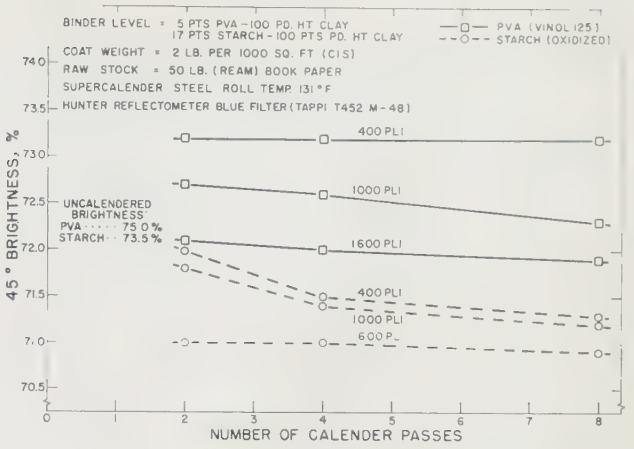

BINDER LEVEL = 5 PTS PVA-100 PD. HT. CLAY
17 PTS STARCH-100 PTS PD. HT. CLAY
PVA (VINOL 125)
STARCH (OXIDIZED)
COAT WEIGHT = 2 LB. PER 1000 SQ. FT. (CIS)
RAW STOCK = 50 LB. (REAM) BOOK PAPER
SUPERCALENDER STEEL ROLL TEMP. 131°F
HUNTER REFLECTOMETER BLUE FILTER (TAPPI T452 M-48)
400 PLI
1000 PLI
1600 PLI
UNCALENDERED BRIGHTNESS:
PVA 75.0%
STARCH .. 73.5%
45° BRIGHTNESS, %
NUMBER OF CALENDER PASSES

Fig. 8. Effect of calendering on brightness of starch and polyvinyl alcohol coatings

Optical Properties

We were particularly anxious to investigate the optical properties of PVA-clay paper coatings. That is, opacity, brightness, and gloss. Many people have expressed the thought that a binder is but a necessary evil and that the greatest utilization of the pigments' capabilities would be realized if no binder were present at all. With its very high adhesive strength, PVA produces coatings which approach this "no binder" ideal. Willets and Marchetti (*5*, *6*), and Cobb (*7*) have discussed the merits of having a high pigment-to-binder volume ratio in paper coatings. This is called a high PVC, or pigment volume concentration. Basically, when less binder is used, pigment-resin interfaces are replaced by pigment-air interfaces; and, in view of refractive index considerations, opacity and brightness properties are improved. In addition, in a low binder system for a given weight of coating more pigment is present.

With regard to gloss, the low binder level allows for greater ease of flow of the clay plateles during calendering, and a smoother surface is obtained. And, since spectral reflectance is also a function of refractive index—higher index yielding greater reflectance—the presence of more pigment in a unit of surface area favors improved gloss.

A 5 pt. PVA-clay coating has a PVC of 90.3 as compared to 74.3 for a 20 pt. starch coating, and 76.7 for a 15 pt. protein coating of similar pigmentation. The data that follow will demonstrate how this low binder content is reflected in terms of gloss, brightness and opacity.

Gloss. Figure 6 shows the gloss values obtained as a function of binder content level for various adhesives (TAPPI Standard T 480 m-51 was followed). These coatings were all of the same coat weight (4.5 lb. per 1000 sq. ft.) and were supercalendered under the same loading (500 p.l.i.). It can be seen that with any particular adhesive a marked increase in gloss results by going to lower binder content, and that, indeed, considering the data as a whole, neglecting what the individual adhesives are, there appears to be an almost linear relationship between binder content and gloss. The contribution of themoplasticity to gloss cannot, however, be overlooked; and this is demonstrated by the fact that wherever latex is involved a definite improvement in gloss was realized.

Figure 7 again demonstrates the greater ease of obtaining gloss with low binder content coatings. In this case rather low coat weights were involved (2 lb. per 1000 sq.ft.) and the comparison is with a starch coating. The choice of 17 pt. starch, which is somewhat less than the adhesive equivalent of 5 pt. PVA, actually favored the starch optically. It is readily seen that at any loading the PVA coatings yielded higher gloss values. In general then, in order to obtain a given degree of gloss, less calendering is required with a coating of high

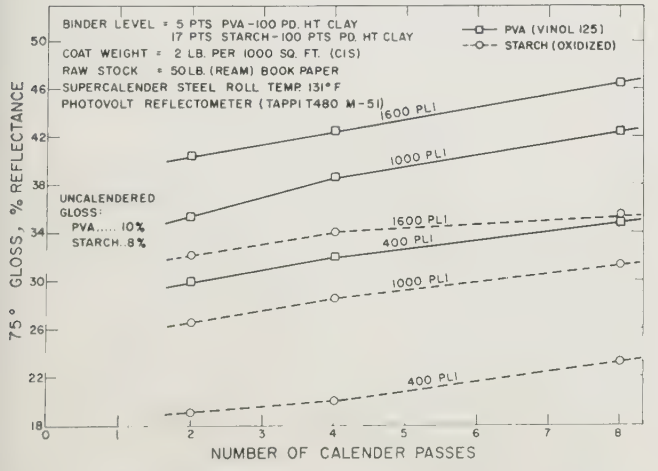


Fig. 7. Effect of calendering on gloss of starch and polyvinyl alcohol coatings

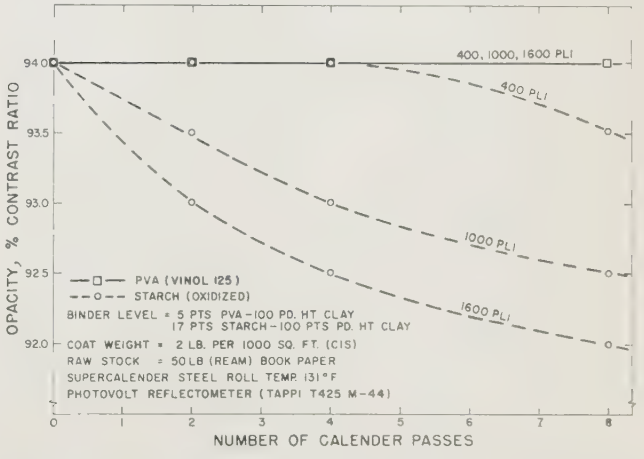

400, 1000, 1600 PLI
400 PLI
1000 PLI
1600 PLI
PVA (VINOL 125)
STARCH (OXIDIZED)
BINDER LEVEL = 5 PTS PVA-100 PD. HT. CLAY
17 PTS STARCH-100 PTS PD. HT. CLAY
COAT WEIGHT = 2 LB. PER 1000 SQ. FT. (CIS)
RAW STOCK = 50 LB. (REAM) BOOK PAPER
SUPERCALENDER STEEL ROLL TEMP. 131°F
PHOTOVOLT REFLECTOMETER (TAPPI T425 M-44)
OPACITY, % CONTRAST RATIO
NUMBER OF CALENDER PASSES

Fig. 9. Effect of calendering on opacity of starch and polyvinyl alcohol coatings

PVC—and calendering is, of course, a destructive process.

Brightness. The brightness data in Fig. 8 were obtained with the same coatings used in obtaining the gloss data of Fig. 7. (TAPPI Standard T 452 m-48 was followed). It is seen that the PVA coatings exhibited anywhere from 1 to 2 points higher brightness under a given loading, a difference which is discernable by the human eye. Comparing coatings of equivalent gloss, e.g., the 400-p.l.i. PVA coatings and the 1600-p.l.i. starch coatings, approximately a $3^1/_2$ point brightness difference exists.

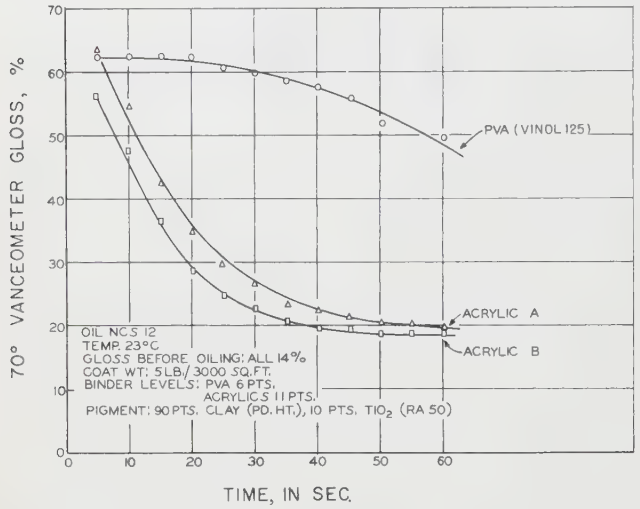

70° VANCEOMETER GLOSS, %
TIME, IN SEC.
PVA (VINOL 125)
ACRYLIC A
ACRYLIC B
OIL NO.5 12
TEMP. 23°C.
GLOSS BEFORE OILING: ALL 14%
COAT WT: 5 LB./ 3000 SQ.FT.
BINDER LEVELS: PVA 6 PTS.
ACRYLIC A 11 PTS.
PIGMENT: 90 PTS. CLAY (PD. HT.), 10 PTS. TiO2 (RA 50)

Fig. 10. Vanceometer oil absorption rates of bread wrap coatings

Table IV compares the brightness of the various binders previously compared in terms of strength in Fig. 5. The PVA coatings are seen to display up to a 4-point advantage. And, again, greater differences would have been obtained had the coatings been calendered to the same gloss rather than under the same loading.

Opacity. The data shown in Fig. 9 were obtained using the same PVA and starch coatings that were employed in obtaining the gloss and brightness data of Figs. 7 and 8 (TAPPI Standard T 425 m-44 was followed). The opacity retention of the PVA coatings when calendered is seen to be significantly greater than that of the starch coatings. The lack of any loss in the opacity of the PVA coatings on calendering at 400, 1000, and 1600 p.l.i. was surprising to us. Although low-binder content PVA coatings do retain better calendered opacity, they do not always display the complete retention that is seen with this particular stock.

Water Resistance

The greatest obstacle to complete acceptance of PVA in the large volume, commercial grades of paper is the difficulty in obtaining complete water resistance. Paradoxically, PVA is often added to starch colors to provide them with greater water resistance and it is used commonly in one type of paper that must be highly water resistant—paper offset lithographic printing plates.

Although PVA can be made water resistant by using any of several curing agents, in view of discoloration and other considerations, the most practical curing agents at present are the urea and melamine formaldehydes. Both will provide adequate cure if sufficient heat energy is put into the coated surface during drying. Under most mill-drying conditions, however, sufficient energy is not available, and the coating usually depends on after-cure at room temperature to achieve water resistance. Trimethylol melamine cures well at room temperature, whereas the ureaformaldehydes do not. On the other hand, the trimethylol melamines produce viscosity stability problems in high solids colors.

Hence, none of the curing systems presently available are suited to all situations, but with process or equipment modification coatings having excellent water resistance can be obtained. Infrared drying and steam-drum drying are the preferred drying methods, for with these the coated surface itself can reach a high temperature without the remainder of the sheet being overdried.

Table IV. Brightness of Various Binders
100% Clay coatings

Binder	*Total binder, pt. per 100 pt. clay*	*Brightness (45°), %*
Casein	15	78.5
Casein $^2/_3$-B/S $^1/_3$	15	77.6
Soy protein	15	77.0
Soy protein $^2/_3$-B/S $^1/_3$	15	76.1
Starch	20	77.1
PVA	5	80.1

Oil and Grease Resistance

In oil and grease resistance PVA is particularly outstanding. PVA will improve the oil and grease resistance of starch, soy protein, and casein coatings, even if added in only small quantities.

An example of the oil resistance of 100% PVA-clay coatings is shown by the Vanceometer plots of Fig. 10. Here, a comparison was made with acrylic latex binders on an overwrap raw stock. In using the Vanceometer a thin film of oil is spread over the paper to be tested. The oil resistance is measured by the change of gloss of the surface as the oil penetrates the stock. It can be seen that the PVA exhibited greater holdout.

Since typical waxing materials, e.g., paraffin, microcrystalline, and polyethylene are essentially high-molecular-weight oils, it was expected that wax holdout would be greater with the PVA coatings and that greater waxed opacity would therefore be realized. When waxed the PVA, Acrylic "B," and Acrylic "A" coatings showed opacity contrast ratios, respectively, of 61, 59, and 58.

LITERATURE CITED

1. Shipp, J. H., U. S. pat. 2,251,296 (Aug. 5, 1941).
2. Casey, J. P., "Pulp and Paper," Vol. II, p. 1029, New York, Interscience Pub., Inc., 1952.
3. Mosher, R. H., "The Technology of Coated and Processed Papers," p. 116, New York, Chemical Publishing Co., Inc., 1952.
4. Rohm & Haas Co., Philadelphia, Pa., *Resin Review* Vol. 9, No. 2: 14–21 (1959).
5. Willets, W. R. and Marchetti, F. R., *Tappi* 41, No. 12: 743–749 (Dec., 1958).
6. Marchetti, F. R. and Willets, W. R., *Tappi* 43, No. 3: 273–276 (March, 1960).
7. Cobb, R. M. K., *Tappi* 41, No. 10: 581–600 (Oct., 1958).

Received May 1, 1961. Presented at the 12th Coating Conference of the Technical Association of the Pulp and Paper Industry, held in Buffalo, N. Y., May 8–10, 1961.

Reactive Lignin-Derived Products in Phenolic, High-Pressure Laminates

C. F. SCHULERUD and J. B. DOUGHTY

Two new products, Reax 23 and 31, derived from lignin, which are co-reactants for phenolic resins have been developed by West Virginia Pulp and Paper Co. They can be used along with phenolic in most of the usual applications, including molding compounds, thermal-insulation binders, and high pressure laminate varnishes. They have been shown to react chemically in phenolic systems and to become an integral part of the cured resin. Decorative and industrial laminates having better than NEMA specifications properties have been made using as high as 60 parts of the lignin derivatives to 40 parts of phenolic resin for the varnish solids. Laminated products of cotton, asbestos, nylon, and glass fiber are also being made with them. The materials can be used with most of the commercial phenolic-laminating resins, but best results are obtained with a "green," alkali-catalyzed, water-dilutable resin of the type commonly used as a thermal-insulation binder. They can be used with formaldehyde resins of phenol, cresol, or cresylic acids as well as furfural-phenol condensates. The lignin-derived products can be easily blended with the phenolic resins; being soluble in most, and are also soluble in resin-alcohol solutions or in resin-alcohol-water solutions. Varnishes containing these can be used in the usual commercial treaters and the treated paper or cloth can be pressed with normal presses and press temperature-pressure-time cycles. Laminates with good mechanical and electrical properties are being made with these materials. Decorative laminates with less warp, good shearing qualities, and improved flatness are prepared with varnishes containing the derivatives. Very good machining and punching properties are a feature in industrial laminates made of the lignin products.

THE idea of using lignin materials as extenders of phenolic resins in laminates, molding compounds, and other applications is not new. Most of the proposed techniques are presented in two excellent bibliographic works compiled at The Institute of Paper Chemistry (*1*, *2*). Only a very limited utilization has been made in the past of these materials in this field. This lack of success seems to be due to the fact that either the products or process for using the products have not been economical. In some instances very expensive solvents are suggested for use with the lignins. In others, such as paper-base laminates, a complex "beater additive" technique is proposed, and in others very expensive phenolic resins are recommended to be used with the lignins. The two principal objections to the use of lignins in the high-pressure laminate field are the high viscosity imported to the treating varnishes by the lignins, and the poor reactivity of the lignins with the phenolic resins used. Investigations at the research laboratories of West Virginia Pulp and Paper, and elsewhere, have shown that lignin as recovered directly from the pulping liquors is not satisfactory for use as an extender and co-reactant in such applications. Our studies have shown, however, that useful additives for resins and plastics can be made by chemical modification of selected fractions of the phenolic constituents of wood. These have also shown that for best results a judicious selection of the resin to be used with the modified product is required. As a consequence of this work we have developed a group of phenolic wood polymers under the tradename of Reax. Two of these products were developed especially for use with phenolic resins; namely, Reax 23 and Reax 31. The present paper is concerned with the application of these products as co-reactants with the phenolic resins in high-pressure laminates.

C. F. SCHULERUD, Research Chemist, and J. B. DOUGHTY, Assistant Research Director, Research Laboratory, West Virginia Pulp and Paper, Charleston, S. C.

REAX—PHENOLIC POLYMERS

Origin of Reax

Reax is derived from phenolic wood polymers which are thought to be formed in growth processes by the condensation of coniferyl alcohol (Fig. 1).

In the initial step of this condensation, enzymes dehydrogenate the coniferyl alcohol at one or more of the following potential points: (1) at the phenyl hydroxyl, (2) at the adjacent nuclear hydrogen atom, (3) at any of the hydrogens in the side-chain. Removal of hydrogen atoms at these points results in the formation of several different types of free radicals, which then polymerize spontaneously to form a number of polymers containing variations of the coniferyl alcohol unit; i.e., a phenolic nucleus with a three-carbon side-chain.

Reax, although not identical in structure with the original wood polymers, is also composed of these phenolic nuclei cross-linked to form a mixture of phenolic polymers having an average molecular weight of 800 to 2000. Since it originates from the alkaline cooking of wood, Reax is free of sugars. Like polymerized phenolic resins, the total configuration of these phenolic polymers is not entirely known, although they are thought to be of a much more ordered structure than is a cured phenolic resin. Because more ordered or oriented structures result in resins of greater physical strengths when properly curved, this has led to the

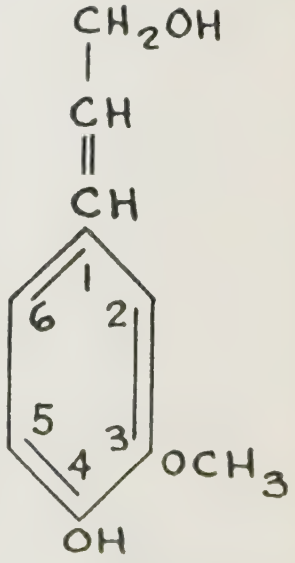


Fig. 1. Coniferyl Alcohol (3)

belief that very effective thermosets could be made by cross-linking the polymers to form cured compounds of high molecular weight.

Reactive Groups in Reax

Effective cross-linking is dependent on the presence of reactive groups or atoms in the structure of the polymer. Although the total configuration of Reax polymers is not yet precisely established, a great deal is known about its substituent groups and reactive points. For example, it is known to contain up to seven hydroxyl groups per 1000 molecular weight, of which between three and four are phenolic and the others alcoholic. It also contains carbonyl groups of several different types, including carboxyl groups which, in conjunction with the phenolic hydroxyls, render Reax soluble in alkali.

The most obvious point of reaction in phenolic resin systems is the activated hydrogen at the number 5 position of a free phenolic nucleus. This position is open in more than half the phenolic nuclei in Reax, and as many as two methylol groups per 800 to 1000 molecular weight have been introduced by the reaction of this activated carbon with formaldehyde.

Mechanism of Cure in Reax Systems

The activated carbon at the number 5 position is available for reactionwith methylol groups contained in phenolic resins mixed with Reax. Steric hindrance prevents the large Reax molecule from reacting readily with the more advanced phenolic resins [late B or early C stage resins (*3a*) with molecular weights 1000 to 2000]. On the other hand, Reax reacts easily with phenol alcohols and methylolated phenols, both of which are present in less advanced phenolic resins (molecular weight $<$ 1000). Therefore, the best lamination results are obtained with relatively green resins of a high formaldehyde-to-phenol ratio.

Reax can react with formaldehyde to add methylol groups to its structure, and it can be used with formaldehyde alone to form a resin. The resulting resin, however, does not cure to as strong a thermoset. This mechanism would require the condensation of the relatively large methylolated Reax molecules. This does not occur rapidly enough because of steric hindrance. When methylolated phenols are used, however, they can react with the Reax, as well as with other methylolated phenols or less advanced polymers having a sufficiently high degree of mobility, to reduce the effects of steric hindrance.

Attempts have also been made to introduce Reax to the resin kettle, along with phenol and formaldehyde in the initial charge. In conventional formulas this inhibits the very necessary formation of methylolated phenols. This inhibition is caused largely by the pickup of the alkaline catalyst by Reax which, as mentioned previously, contains acidic groups. More catalyst can be added but this may result in high ash contents not conducive to good water resistance or good electrical properties.

Optimum pH in Reax Cures. The process of polymerization in Reax systems parallels conventional phenolic resin condensations in that both methylene bridges and benzyl ether type linkages occur, depending on conditions. Reax, since it contains extra hydroxyl groups, can form ether linkages either by direct reaction of these hydroxyls or by the usual route of adding methylolated phenols at the active hydrogens.

It is known that the ether-type linkage is fostered in conventional phenolic resins by control of pH within the range of 3.5 to 5.5 (*4*). Unless excessive amounts of catalyst are added, the natural acidity of Reax tends to control the pH within this range. In this behavior Reax, being a weak organic acid, serves to buffer the pH of the resin system, keeping it in the range which promotes formation of ether linkages. Such linkages are subject to the forces of hydrogen bonding, which is believed to account for the better strength for resins cured at pH 3.5 to 5.5 than would be obtained at other pH's. By making relatively large changes in the amount of catalyst used, the pH can be adjusted to values outside this range. In this instance adequate resins can often be produced, but their properties are not usually as good as those produced in the optimum pH range of 3.5 to 5.5.

It should be pointed out that it is very difficult to control pH within the ether-forming range in conventional phenolic resin systems. In such systems no buffer is present, and the use of strong acids to lower the pH calls for such delicate control as to be commercially impractical.

Description of Reax

Reax materials are available as granular, brown powders or as alcoholic solutions. Reax 23, the first material developed for laminating, although yielding excellent results in many laminating applications, produced high viscosities in some resin systems, notably in resins for scraper bar impregnation of decorative core stock where high solids-to-viscosity ratios were desired. Reax 31 was developed to provide the lower viscosity, where it was necessary. This material is essentially a lower molecular weight version of Reax 23 and, other than producing a lower viscosity at a given concentration, it yields laminates with equal strength.

These resin co-reactants dissolve in phenol, but are insoluble in mineral acids. They are insoluble in water, except under highly alkaline conditions. Solvents for these polymers include glycols, cellosolves, amines, dioxane, and alcohol-ketone mixtures. Above 50% solute content the Reax is soluble in methanol, ethanol, isopropanol, and various mixtures of these alcohols and water. Below a solids level of 45%, alcohol and alcohol-water mixtures of Reax have a marginal stability. However, small amounts of ketones, particularly acetone, will re-establish stable solutions to considerably below 40% solids. Reax 23 and 31 are insoluble in hydrocarbons, some chlorinated solvents, ethers, and esters.

Neither Reax product is easily decomposed by heating. Very little decomposition occurs below 400°F., and only a small amount of material is lost upon heating to 570°F. These materials do not exhibit sharp melting points, but sinter over a rather narrow temperature range. Reax 23 and 31 sinter at about 400°F. and 340°F., respectively; the presence of small amounts of water or alcohol will markedly lower these sintering points.

The Reax materials are nontoxic and nonhygroscopic. They exhibit an equilibrium moisture content, which varies from 0 to 7%, depending on environmental

humidity. The shelf-life of the powdered forms of Reax is infinite. The alcoholic solutions (methanol and isopropanol–water) of these materials also have excellent storage stability. A viscosity increase between 50 and 75% over the initial solution viscosity, owing to increased solvation of the material, may occur in the first 7 to 10 days of storage. However, barring solvent loss these solutions will show no aging characteristics beyond this initial viscosity change.

Reax in Phenolic Resins

Laboratory and plant experience with Reax materials has indicated a compatibility with a wide variety of phenolic and natural tar acid resins, as well as with a number of furfural-modified phenol-formaldehyde condensation products. Tables I to III show laminate data obtained with several resins. Resin contents in the laminates vary from the 32 to 34%, found in kraft filled decorative laminates, to the higher resin ranges encountered in the industrial grades. The ratio of Reax-to-resin solids in these formulations was varied from 1 : 2 to 2 : 1 or 50% to 200% extension of the phenolic resin. In all formulations shown the Reax was added at the completion of the reaction In general, these data are offered as a demonstration of the performance of Reax with resins prepared under a wide variety of conditions.

Table I shows the properties of some decorative laminates made with Reax 23 and 31 and various sodium hydroxide catalyzed resins. The results demonstrate conclusively that resins with phenol-to-formaldehyde ratios varying from 1 : 1.5 up to 1 : 2.0 can be used with the Reax materials. These resins were less advanced polymers with high water dilutability. The data of Table I, however, show that the phenol-to-formaldehyde ratio cannot be too high, because the laminates made with a phenol-formaldehyde ratio of 1 : 1.2 were not well bonded and gave high water-absorption and swelling values. At such a mole ratio the reactivity of Reax with the resin is reduced to a point where it performs more as a filler or extender than in its proper function as a co-reactant.

Table II presents data on tests of decorative laminates made with Reax 23 and 31 as co-reactants with barium hydroxide–catalyzed resins. The data of Table III also show how alkaline-catalyzed resins of

Table I. Decorative Laminates Prepared from Reax and Various NaOH-Catalyzed Phenolic Resins

Composition of resin cook as phenol : formaldehyde : NaOH, equiv.	*Reax 23* — *Clupak saturating kraft*[b]						*Reax 31* — *Luke saturating kraft*[c]			
	1:2.0 : 0.07		*1:1.5 : 0.05*		*1:1.75 : 0.06*		*1:1.75 : 0.06*		*1:1.2 : 0.05*	
Resin-Reax ratio (solids)	1:1	2:1	1:1	2:1	1:1	2:1	2:1	1:1	2:1	1:1
Laminate resin content, %[a]	34.0	34.1	33.4	32.9	34.6	34.2	32.3	33.6	32.2	32.1
Thickness of laminate, in.	0.067	0.066	0.064	0.063	0.065	0.066	0.066	0.066	0.065	0.064
Approx. density of laminate, g./cc.	1.440	1.449	1.465	1.501	1.471	1.449	1.469	1.487	1.443	1.464
Water absn. (2 hr. boiling), %	4.9	4.1	5.6	4.8	6.2	3.8	5.7	6.4	9.4	11.9
Swelling in boiling water, %	4.5	3.1	6.3	4.7	6.2	3.1	4.7	6.1	11.1	17.2
Izod impact strength (edgewise), ft.-lb./in.	0.58	0.52	0.62	0.64	0.61	0.60	...	...	...	...
Rockwell hardness (core side), M scale	101	98	101	103	102	102	...	...	...	...
Flex. strength (decorative side convex), p.s.i.	18,575	21,545	19,925	20,852	18,407	20,717	...	...	...	...

Press cure cycle: 270 to 290°F., 20 min. above 270°F., 1000 p.s.i.
[a] Resin content calculated on moisture-free paper.
[b] Clupak saturating kraft, West Virginia Pulp and Paper, Charleston, S. C.
[c] Luke saturating kraft, West Virginia Pulp and Paper, Luke, Md.

Table II. Decorative Laminates Prepared from Reax and Various BaO-Catalyzed Phenolic Resins

Composition of resin cook as phenol:formaldehyde:BaO, equiv.	*Reax 23* — *Clupak saturating kraft*[b]						*Reax 31* — *Luke saturating kraft*[c]	
	1:2.0 : 0.06		*1:1.75 : 0.05*		*1:1.5 : 0.04*		*1:1.75 : 0.05*	
Resin-Reax ratio (solids)	1:1	2:1	1:1	2:1	1:1	2:1	2:1	1:1
Laminate resin content, %[a]	32.9	33.3	32.8	33.3	32.2	32.1	31.3	31.9
Thickness of laminate, in.	0.065	0.065	0.065	0.065	0.065	0.064	0.064	0.047
Approx. density of laminate, g./cc.	1.446	1.443	1.422	1.449	1.450	1.459	1.449	1.467
Water absn. (2 hr. boiling), %	4.8	7.1	7.6	6.8	5.9	5.6	6.3	7.4
Swelling in boiling water, %	4.7	4.7	7.7	4.6	6.2	6.3	6.3	6.4
Izod impact strength (edgewise), ft.-lb./in.	0.62	0.61	0.65	0.59	0.66	0.60	0.58	0.66
Rockwell hardness (core side), M scale	97	88	90	83	100	101	100	102
Flex. strength (decorative sheet convex side), p.s.i.	20,420	21,090	20,044	20,080	21,196	20,548	20,118	20,399

Press cure cycle: 270 to 290°F., 20 min. above 270°F., 1000 p.s.i.
[a] Resin content calculated on moisture-free paper.
[b] Clupak saturating kraft, West Virginia Pulp and Paper, Charleston, S. C.
[c] Luke saturating kraft, West Virginia Pulp and Paper, Luke, Md.

Table III. Reax 23 with Various Phenolic Resins in Industrial Kraft Paper Laminates

Resin formulation					*Varnish*						*Laminate*			
	HCHO		*NaOH*											
Phenol, parts	*Parts*	*Mole ratio*[a]	*Parts*	*Mole ratio*[a]	*Reax 23, parts*	*EtOH, parts*	*H_2O, parts*	*Total solids, %*	*Visc. at 25°C., c.p.s.*	*Reax 23-to-resin ratio*	*Thickness, in.*	*Total Reax 23 resin, %*	*Flexural strength, p.s.i.*	*Water absn., %*
100	48	1.5	2.1	0.05	122	79	117	55	260	1:1	0.076	42.3	24,923	3.0
100	48	1.5	2.1	0.05	120	79	117	55	308	1:1	0.074	41.2	25,361	3.0
100	48	1.5	2.1	0.05	120	79	117	55	370	1:1	0.076	42.0	25,434	2.8
100	77	2.5	2.1	0.05	254	254	189	46	360	2:1	0.125	34.0	24,266	1.5
100	48	1.5	1.1	0.025	120	79	117	55	224	1:1	0.111	34.0	27,221	2.6
100	77	2.5	1.1	0.025	254	254	189	46	300	2:1	0.115	34.2	26,559	2.1
100	28	...	2.1	0.05	61	131	73	48	532	1:2	0.121	37.7	27,391	4.5
100	29	...	2.1	0.05	65	82	77	55	500	1:2	0.120	37.5	28,021	2.8

Press conditions: first three samples—1 hr., 300°F., 1000 p.s.i.
last five samples—1 hr., 275°F., 1000 p.s.i.
[a] Mole ratio to phenol.

varying phenol–formaldehyde content can be used with the Reax products.

Although it is not intended that the formulations shown be considered the best, or the only combinations for Reax modification, results of our investigation of resins have definitely indicated that better laminates are produced with phenol-to-formaldehyde ratios below 1 : 1.5. The increased methylolation of resins produced by high formaldehyde concentration in the initial mixture favors the reaction necessary to chemically link the Reax. As indicated previously, a pH range in the final Reax–resin blend of 3.5–5.5 is desirable, since this area favors the formation of the desired chemical bonds. Resin–Reax blends in this pH range generally exhibit the best cure time and flow characteristics.

In addition to high formaldehyde-to-phenol ratios it is desirable to have these resins remain as "green" as

Table IV. Industrial Laminates of Reax 23 and Various Cresol and Cresylic Acid–Formaldehyde Resins

Resin used[a]	*Laminate resin content,*[b] *%*	*Processing at 1000 p.s.i. Temp., °F.*	*Time, hr.*	*Thickness of laminate, in.*	*Approx. density of laminate, %*	*Water absn. 24 hr. immersion, %*	*Flexural strength, p.s.i.*	*Modulus of elasticity, p.s.i.*
Barrett cresol R-3-A	54.6	300	0.5	0.072	1.422	3.9	23,938	1.207×10^6
	60.0	300	1.0	0.137	1.384	1.1	23,772	1.031
	60.0	300	1.0	0.135	1.413	1.1	24,181	1.081
Barret cresylic acid	41.2	300	0.5	0.068	1.362	10.2	21,386	1.174
D-4-A	40.1	300	1.0	0.119	1.321	5.9	27,609	1.111
	40.0	300	1.0	0.119	1.310	5.0	27,909	1.120
Barrett cresylic acid	56.6	250	0.5	0.074	1.388	14.7	19,998	1.168
No. 6	51.1	250	1.0	0.125	1.422	8.0	24,128	1.034
	51.5	250	1.0	0.126	1.420	6.8	24,896	1.017
Pitt-Consol cresylic	42.0	275	0.5	0.070	...	8.2	24,000	...
acid No. 5	41.0	275	1.0	1.121	...	4.4	27,300	...
	44.0	275	1.0	0.242	...	2.1	27,000	...
Pitt-Consol cresylic	40.0	275	0.5	0.060	...	7.3	29,500	...
acid No. 7	40.0	275	1.0	0.120	...	2.9	27,800	...
	40.0	275	1.0	0.240	...	1.8	27,500	...

[a] Molar ratio of cresol- or cresylic acid-to-formaldehyde cooked 1:1.5 with 0.05 mole NaOH used as catalyst. Reax 23-to-resin solids in the varnish 1:1, methanol used as solvent for varnish.
[b] Resin content calculated on moisture-free paper.
Coal Chemicals and Plastics Division, Allied Chemical Corp., New York, N. Y.
Pitt-Consol Chemical Co., Newark, N. J.

Table V. Laminates of a 1:1 Blend of Reax 23 and Various Phenol-Furfural-Formaldehyde Resins

Mixture reacted	*Laminate resin content,*[a] *%*	*Pressing time at 300°F. and 1000 p.s.i., hr.*	*Thickness of laminate, in.*	*Approx. density of laminate, g./cc.*	*Water absn. (2 hr. boil), %*	*Flexural strength, p.s.i.*	*Modulus of elasticity, p.s.i.*
Phenol-3 mol	32.0	0.5	0.066[b]	1.443	7.16	25,177	1.324×10^{-6}
HCHO-3 mol							
Furfural-1 mol	32.1	1.0	0.118	1.449	3.66	26,447	1.111
NaOH 6 g	32.1	1.0	0.117	1.460	3.38	26,756	1.099
Phenol-3 mol	33.3	0.5	0.067[b]	1.399	5.42	25,906	1.339
HCHO-3 mol							
Furfural-1 mol	33.0	1.0	0.119	1.426	2.93	26,762	1.114
NaOH 6 g	33.0	1.0	0.121	1.397	3.18	25,996	1.029
Phenol-6 mol	32.0	0.5	0.066[b]	1.409	4.44	25,670	1.529
HCHO-8 mol							
Furfural-1 mol	31.9	1.0	0.117	1.428	2.41	27,570	1.298
NaOH 12 g	31.9	1.0	0.117	1.432	2.41	27,772	1.246

Press cure cycle: 270 to 290°F., 20 min. above 270°F., 1000 p.s.i.
[a] Resin content calculated on moisture-free paper.
[b] Decorative laminate, all the others industrial panels.

Table VI. Evaluation of Industrial Laminates Made from Luke 100 lb. Saturating Kraft Paper, and Blends of Reax 23 and Bakelite BRL 1100

Resin used	*Bakelite BRL 1100*						*NEMA's X grade std.*
Resin-to-Reax 23 ratio (solids)	2:1	2:1	2:1	1:1	1:1	1:1	...
Solids of varnish, %	40	40	40	40	40	40	...
Surfacing sheet[a]	No	No	Yes	No	No	Yes	...
Laminate resin content, %[b]	34.9	32.7	32.0	35.7	32.8	32.7	...
Thickness of laminate, in.	0.123	0.117	0.117	0.124	0.121	0.121	...
Approx. density of laminate, g./cc.	1.500	1.494	1.476	1.480	1.460	1.457	...
Water absn., %							
24-hr. immersion	2.9	3.1	2.9	2.8	2.8	2.8	3.30
2-hr. boiling	3.5	3.3	3.1	3.8	3.2	3.2	...
Swelling in boiling water, %	1.7	2.6	2.6	2.4	2.5	3.4	...
Izod impact strength (edgewise), ft.-lb./in.	0.58	0.60	0.64	0.53	0.57	0.68	0.5
Rockwell hardness (core), M scale	90	94	98	95	94	94	110
Flexural strength, p.s.i.	23,152	25,496	25,253	19,791	22,135	25,277	22,000 25,000

Press cure cycle: 350°F. in 40 min.—350°F. 1 hr., 1000 p.s.i.
[a] Bakelite CLS 3914 impregnated surfacing sheet.
[b] Resin content calculated on moisture-free paper.
Luke saturating kraft, West Virginia Pulp and Paper, Luke, Md.
Bakelite BRL 1100, Union Carbide Plastics Co., Bound Brook, N. J.

Table VII. Comparison of Decorative Laminates Made in Our Laboratory with Standard Decorative Varnishes and Reax-23

Resin used with reax 23	*Plenco[a] 217*	*Resinox[b] 451*	*Catalin[c] 9822*	*Resinox[d] H-212*	*NEMA std.*
Thickness of laminate, in.	0.064	0.060	0.066	0.066	0.063
Water absn. (2 hr.—boiling), %	7.4	5.0	5.6	8.5	10.0
Swelling in boiling water, %	7.4	5.5	6.4	9.7	10.0
Izod impact strength (edgewise), ft. lb./in.	0.70	0.63	0.63	1.09	0.50
Rockwell hardness (core), M scale	90	102	99	95	...
Flexural strength (decorative sheet convex), p.s.i.	20,000	21,000	19,000	18,000	12,000
Toughness (decorative sheet convex), in-lb./sq. in.	24	23	24	20	...

[a] Plastics Engineering Co., Sheboygan, Wis.
[b] Monsanto Chemical Co., Springfield, Mass.
[c] Catalin Corp., 1 Park Ave., New York, N. Y.
[d] Resinox H-212, Monsanto Chemical Co., Springfield, Mass.

possible. Short reaction times and/or low reaction temperatures, producing resins with a high water tolerance, yield Reax modified laminating resins with a desirably high solids-to-viscosity ratio. In treating these resins the Reax ties up the free formaldehyde and other low-molecular-weight materials, thus producing high yields.

Historically, less advanced or water-soluble type resins have met with limited favor in the laminating industry, particularly in the decorative laminate area. These resins, although providing excellent penetration of paper and outstanding water resistance in the finished decorative panel, tend to produce a brittle laminate with undesirable flow characteristics during laminating and poor efficiencies in treating. Also, the excellent penetration accomplished during impregnation results in reduced wet strength in the web, and thus frequent paper breaks.

It is most important to distinguish these conditions from those produced with an Reax-modified, less advanced or water-soluble type resin. When modified with Reax in the concentration under discussion (2 : 1 or 1 : 1 resin solids to Reax) such resins cease to perform as water-soluble materials. Their treating and laminat-

Table VIII. Comparison of Decorative Laminates Made in Our Laboratory with Low Advanced Resins and Reax 23

Resin used with Reax 23	*BRL[a] 1100*	*Catalin[b] 175*	*Catalin[b] 177*	*Amres[c] N-431*	*Tybon[c] 5305*	*NaOH[d] catzd.*	*BaO[d] catzd.*	*NEMA std.*
Thickness of laminate, in.	0.064	0.065	0.065	0.065	0.065	0.065	0.065	0.063
Water absn. (2 hr.—boiling), %	5.0	4.8	4.4	4.5	4.8	5.5	6.5	10.0
Swelling in boiling water, %	6.0	5.0	4.4	4.5	6.0	6.0	6.5	10.0
Izod impact strength (edgewise), ft. lb./in.	0.60	0.60	0.58	0.56	0.56	0.60	0.62	0.50
Rockwell hardness, M scale	101	100	100	97	99	102	95	...
Flexural strength (decorative sheet convex), p.s.i.	19,000	19,000	21,000	21,000	20,000	19,000	20,000	12,000
Toughness, (decorative sheet convex), in.-lb./sq. in.	20	25	25	24	21	22	24	...

[a] Union Carbide Plastics Co., Bound Brook, N. J.
[b] Catalin 175 and Catalin 177, Catalin Corp., 1 Park Ave., New York, N. Y.
[c] Amres N-431 and Tybon 5305, American Marietta Co., Newark, Ohio.
[d] NaOH and BaO catalyzed resin made in Research Laboratory, West Virginia Pulp and Paper, Charleston, S. C.

Table IX. A Comparison of Laminates Prepared with Varnishes of BRLA 1030 and BRL 1100 Together with Various Amounts of Reax 23

Bakelite resin used[a]	*BRLA 1030*	*BRL 1100*	*BRLA 1030*	*BRL 1100*	*BRLA 1030*	*BRL 1100*	*BRLA 1030*	*BRL 1100*
Resin-to-Reax-23 ratio	2:1	2:1	1:1	1:1	1:4	1:4	1:8	1:8
Resin in laminate, %	36.8	31.6	37.3	32.0	37.6	39.3	38.0	38.9
Thickness of laminate, in.	0.067	0.062	0.067	0.061	0.071	0.068	0.072	0.070
Izod impact strength (edgewise), ft.-lb./in.	0.56	0.52	0.56	0.53	0.64	0.71	0.57	2.03
Rockwell hardness, M scale	103	105	104	103	92	95	89	83
Flexural strength, p.s.i.	24,200	27,900	24,300	26,700	22,800	21,900	20,800	18,500

All the laminates were cured at 300°F. and 1000 p.s.i. for 1 hr. Then the panels were cooled to almost room temperature at 1000 p.s.i.
[a] Bakelite Resins, Union Carbide Plastics Co., Bound Brook, N. J.

Table X. Decorative Laminates Prepared in Plant Run of Monsanto Resinox[a] 451 and Reax 31

Paper used	*Luke saturating kraft[c]*		*Saturating stock[d]*		*Union Bag-Camp saturating kraft[e]*			
Resin-to-Reax-31 ratio (solids)	3:1		3:1		3:1		3:1	
Treating conditions:								
Speed of treater, f.p.m.	160		184		144		140–150	
Resin content of impregnated paper, %[b]	31.0		29.5		33.0		32.5	
Volatiles, % (6 by 6 in.)	8.5		8.9		8.0		9.4	
Flow-out, % (2 by 2 in.)	4.5		4.0		5.5		7.5	
Properties of laminate:								
Thickness of laminate, in.	0.061	0.061	0.062	0.062	0.063	0.062	0.063	0.063
Approx. density of laminate, g./cc.	1.441	1.434	1.450	1.451	1.445	1.460	1.452	1.440
Water absn. (2 hr.-boiling), %	6.4	6.5	6.1	6.4	6.1	5.9	4.9	5.4
Swelling in boiling water, %	6.5	8.1	6.3	8.1	6.5	6.5	4.8	6.5
Izod impact strength (edgewise), ft.-lb./in.	0.64	0.67	0.65	0.66	0.67	0.66	0.59	0.54
Rockwell hardness (core), M scale	103	103	103	103	106	106	108	108
Flexural strength (decorative side convex), p.s.i	20,837	20,774	20,357	21,892	22,256	19,855	21,917	20,102

[a] Resinox 451, Monsanto Chemical Co., Springfield, Mass.
[b] Resin content calculated using moisture-free paper weight.
[c] West Virginia Pulp & Paper, Luke, Md.
[d] West Virginia Pulp & Paper, Charleston, S. C.
[e] Union Bag-Camp Paper Corp., Franklin, Va.

ing characteristics become almost identical with those to be expected of the conventional laminating varnishes. The resulting mixture acts as a blend of a water–soluble resin and a highly advanced varnish, producing a resin with good penetration and water resistance, while eliminating the undesirable watery type of flow found when straight, water-soluble resin types are laminated.

A large number of commercial resins of both the water soluble and varnish type have been evaluated in the laboratory and in plant trials. Less advanced resins, such as water-soluble materials, yield the best results. One definite advantage of the less advanced type is that considerably higher replacements of phenolic resin solids with the Reax are possible. An extension of 50% can be considered the maximum with varnish-type resins, whereas extensions of 200% are possible with the water-soluble types. Tables IV through XII exhibit data obtained on decorative and industrial laminates prepared with Reax and a variety of commercial resins. Tests of these laminates and those described were made according to NEMA specifications (*5*).

Table IV shows data for kraft laminates made with mixtures of Reax 23 and some cresol and cresylic acid-formaldehyde resins. Generally, these pieces met X or XP properties, but where low cure temperature or times were used the water absorption values were high. The data of Table V are the test values of kraft laminates made with Reax 23 and phenol-furfural-formaldehyde resins. The data in these two tables further emphasize the versatility of the Reax polymers for use in laminates.

The Reax polymers are as useful in industrial laminates as in the decorative core stock. Some data from tests of industrial laminates made with Reax 23 and Bakelite BRL 1100 resin are given in Table VI. Laminates like these are being made with many other phenolic resins which easily pass NEMA specifications for X and XP products and are especially attractive because of their excellent punching properties and dimensional stability.

It is of special interest to note that a wide variety of saturating papers have been used in the laminates prepared and tested in this work.

The advantages of Reax have been demonstrated in a very wide variety of resins, including resins synthesized in our laboratories and many commercial products. The resins used to make the laminates described in Table I through V were made in the West Virginia Pulp and Paper laboratories. The resins used in the other laminates tested were commercial products. Some test data for decorative laminates made of mixtures of Reax 23 and some standard commercial decorative varnishes are given in Table VII. Table VIII shows data for decorative laminates made with mixtures of Reax 23, and several water soluble and water dilutable resins. Resins of this type seem to be the most suitable for use with Reax and allow for the greatest replacement of resin solids by the Reax. They are water soluble, alkali-catalyzed resins. These resins are normally recommended for use as binders for thermal insulation. The phenolic resin-to-Reax ratio used to make these laminates was 1 : 1. It is also of great interest that these thermal-insulation resins are the most inexpensive phenolic resins produced.

The data presented in the previous tables show that the Reax polymers become a definite part of the resin structure, and laminates meeting all industry standards can be prepared with phenolic resin–Reax mixtures. Evidence of the bonding effect of the Reax polymers is dramatically illustrated by the data shown in Table IX. The laminates described were made of resin mixtures containing up to nearly 90% Reax, yet the products had very good strength properties. Had the Reax been a mere extender or filler the strength of these laminates would have dragged tremendously with increasing additions of the co-reactant.

Test data of some decorative laminates made in commercial production are shown in Tables X and XI. These sheets as well as other commercial panels containing Reax were unusually flat. The five sheets described in Table XI were from various production batches of different light-color print sheet designs. No "bleed through" problems were encountered in producing these materials.

Table XI. Evaluation of Commercial Decorative Panels Prepared with Blend of Colar[a] 334 and Reax 23 (1:1 on Solids) and Brown Saturating Paper[b]

Thickness of laminate, in.	0.061	0.061	0.061	0.060	0.062
Approx. density of laminate, g./cc.	1.448	1.442	1.412	1.423	1.423
Water absn. (2 hr.—boiling), %	5.9	5.8	5.6	6.0	6.0
Swelling in boiling water, %	8.1	8.2	8.1	6.9	7.9
Izod impact strength (edgewise), ft.-lb./in.	0.52	0.52	0.52	0.59	0.54
Rockwell hardness (core), M scale	106	105	106	104	100
Flexural strength (decorative side convex), p.s.i.	20,399	23,996	20,624	22,752	20,315

[a] Colar 334, Colab Resin Corp., Tewksbury, Mass.
[b] Brown saturating paper—Brown Paper Co., Berlin, N. H.

Table XII. Industrial Laminates Made with Phenolic Resin-Reax Varnishes
Cures of 1 hr., 300°F. at 1000 p.s.i.

	Bakelite[a]					*NEMA std.*			
	1100 Kraft paper	*1100 Alpha*	*1100 Cotton linters*	*1100 Denim cloth*[b]	*3526 Glass cloth*	*X*	*XX*	*XXX*	*C*
Thickness of laminate, in.	0.122	0.122	0.125	0.116	0.10–0.12	0.125	0.125	0.125	0.125
Water absn. (24-hr. soak), %	2.8	0.3–0.5	0.7–0.8	0.9–3.8	0.08–0.4	3.3	1.3	0.95	2.5
Swelling in boiling water, %	3.2	...	2.9–3.2	5.2–11.0	...	...	...	...	...
Izod impact strength (edgewise), ft. lb./in.	0.60	0.3–0.4	0.5–0.8	1.3–2.4	...	0.50–0.55	0.40–0.35	0.40–0.35	2.1–2.9
Rockwell hardness, M scale	95	100–110	97–100	97–105	...	110	105	110	103
Flexural strength, p.s.i.	23,000	13–16,000	20–28,000	26–31,000	26–74,000	25–22,000	15–14,000	13–11,800	17–16,000
Toughness, in.-lb./sq. in.	60	...	65–71	105–140	...	...	...	...	...

[a] Union Carbide Plastics Co., Bound Brook, N. J.
[b] Cloth sized and dyed.

Table XII lists some typical data of tests of some industrial laminates made with phenolic resin–Reax varnishes. Good punching properties are a very attractive feature of laminates containing Reax. Wheels, gears, and trays have been made with cloth pieces and shreds impregnated with phenolic–Reax resins.

Laminates containing Reax remain dimensionally stable on storage. Data for low and high humidity test and tests of pieces exposed for many months show these to be good or better than those of commercial laminates now on the market.

PREPARATION OF REAX–PHENOLIC BLENDS

Reax 23 or 31 may be blended with "as-received" phenolic resins or, as in the case where resin-producing equipment is available, added during the latter stages or at the end of the resin cook. In this manner the dehydration step, where employed, may be eliminated. Also, where the Reax is added during the latter stages of the reaction, added chemical linking of the Reax and phenolic resin is accomplished. The addition of Reax 23 or 31 powders to a reaction mixture prior to dehydration (approximately 50% solids) will produce an increase in volume of approximately 15 to 20%. Therefore, sufficient volume must be present to allow for this increase.

Investigations of the addition of the Reax materials to phenol–formaldehyde mixtures at the beginning of reaction have indicated that this approach is not practical, because too early addition of Reax inhibits the cure of the phenol–formaldehyde reaction blend, necessitating addition of large quantities of catalysts to overcome this condition. Also, although completely soluble in phenol, Reax 23 and 31 are only partially soluble in water–phenol mixtures. Because of these solubility characteristics, they are best blended with partially reacted mixtures of phenol and formaldehyde.

In most resin systems, the addition of Reax lowers the pH of the final resin blend. Laboratory and field trials indicate that a final-blend pH of 3.5 to 5.5 yields the best laminating results. In this pH range optimum reactivity between the phenolic and Reax is obtained. A final blend pH of 5.0 to 7.0 is to be avoided, as extended gel times and poor laminating properties will be encountered. If the final-mix pH does not fall in the recommended range, a small quantity of acid should be added for adjustment.

The Reax powders may be readily blended with finished resins of either the varnish or water-soluble type. If less advanced resins are used, large quantities may be added, representing as much as 67% of the final-blend solids. The factor limiting the amount which may be added is the viscosity desired in the finished resin. In the treatment of decorative core stock on a scraper-bar equipped wet-end, where a high solids-to-viscosity ratio is desired, an extension of 100% may easily be accomplished. In the instance where squeeze-roll impregnating is employed and lower solids allowable, as high as 200% extension is possible.

When proper mixing equipment is available, Reax–phenolic resin blends are easily prepared. Since the Reax materials are 100% solids, some solvent will normally be added in the case where large replacements are involved, in order to re-adjust the viscosity to a usable range. In general, alcohol or an alcohol–water solvent mixture is used for laminating resins. The solvent should be mixed with the phenolic resin, thus lowering the solids of the resin mixture, followed by the addition of the Reax 23 or 31. Satisfactory agitation must accompany the addition of the powder. In several commercial installations of blending equipment for use with Reax–phenolic systems, it has been found desirable to supplement the agitator with a number of baffles to increase mixing action. Plant experience indicates that blends of 400 to 500 gal. can be made within 15 to 20 min.

Treating with Reax-Phenolic Resin Systems

Treating with Reax–phenolic blends in making either industrial or decorative laminates may be accomplished on conventional equipment. The proper selection of base resin and solvent will allow the treatment of various papers at the normal solids levels employed. One outstanding feature of the impregnation of core stock with Reax phenolic blends is the higher treater speed obtained. Faster drying is a unique feature of Reax modified resins, in that the Reax eliminates the skinning tendencies of phenolic resins during drying. Machine speed increases of 20 to 50% may be obtained in some operations, with no increase in oven temperature.

As might be expected, some minor adjustment in the treated stock properties are required. While normal resin content levels may be maintained, a somewhat different flow-to-volatile ratio can be expected. Typical data for a commercial treatment of decorative core stock are as follows:

Resin content, %	30–32
Flow, %	3.5–5.5
Volatile content, %	7.5–9.0

The above resin content is calculated using "as-received" paper weight as a basis, while the flow test is performed on a 2 by 2 in. specimen laminated at 300°F. for 5 min. A core stock with the above analysis will produce excellent decorative laminates. One other advantage of Reax-modified phenolic systems is that they produce a tack-free, impregnated stock, which can be of importance where treated stock is rewound rather than sheeted.

Laminating of Reax-Modified Phenolic Resins

The lamination of Reax modified phenolic impregnated stock can be carried out under exactly the same conditions employed for conventional resins. No changes in press cure time, temperature, or pressure are necessary.

CONCLUSIONS

Reax may be employed to advantage in replacing phenolic resin solids in a wide variety of resin formulations used in both industrial and decorative laminate. In addition to the substantial savings resulting from lower raw material costs, laminates with better shearing, punching, and machining properties may be obtained.

LITERATURE CITED

1. "Lignin and Lignocellulosic Plastics," Bibliographic Series 166, The Institute of Paper Chemistry, Appleton, Wis.
2. "Paper-Base Plastics," Bibliographic Series 167, The Institute of Paper Chemistry, Appleton, Wis.

2a. Roff, W. J. "Fibers, Plastics, and Rubbers," p. 234, New York, Academic Press, Inc., 1956.
3. Brauns, F. E. and Brauns, D. A., "The Chemistry of Lignin," Suppl. Vol., New York, Academic Press, 1960.
4. Martin, Robert W., "The Chemistry of Phenolic Resins," New York, John Wiley and Sons, 1956.
5. "Laminated Thermosetting Decorative Sheets, Standards Publications," National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N. Y., 1957.

Received Nov. 17, 1960. Presented at the 15th Plastics-Paper Conference of the Technical Association of the Pulp and Paper Industry, held in Syracuse, N. Y., Oct. 17–19, 1960.

Hurletron Moisture Control System

THOMAS M. KEVILLE, JR.

The temperature drop of a sheet as it leaves a fixed temperature drier is directly proportional to its moisture content through a range of 2–15%. This principle is the basis for the Hurletron moisture control system. Such a system was installed on Continental Can's no. 2 paper machine at the Elkart, Indiana mill. After a year of operation the following observations were made: 9% reduction in steam consumption; improved finish and bending properties; reduction in off-quality board due to high moisture; more uniform moisture content.

Moisture control has long been a major problem in the paper industry. Since the moisture content of a sheet of paperboard has a direct bearing on other physical properties, such as tear, stiffness, bender, and dimensional stability, every effort should be made to contain the moisture within the specified limits. In an attempt to control this illusive variable, Continental Can Co. purchased a Hurletron Schie and Straatviet moisture control system and installed it on their no. 2 machine at the Elkhart boxboard mill, where it controls the steam pressure on the last 22 of the 90 driers. This particular machine produces clay-coated board as well as the standard grades of white patent coated, white lined krafts, bleached manila, chip, etc., with a caliper range of 16 to 40 mils.

The Hurletron moisture control system works on the simple principle that the temperature drop of a sheet as it leaves a fixed-temperature drier is proportional to its moisture content, through a range of 2 to 15%. As the sheet passes over the reference drier, the surface fibers assume the same temperature as that of drier. Vapor flashes from the inner fibers, together with normal evaporation, cause a sudden drop in surface temperature. The corresponding temperature drop is directly related to the moisture content of the sheet.

DESCRIPTION OF EQUIPMENT

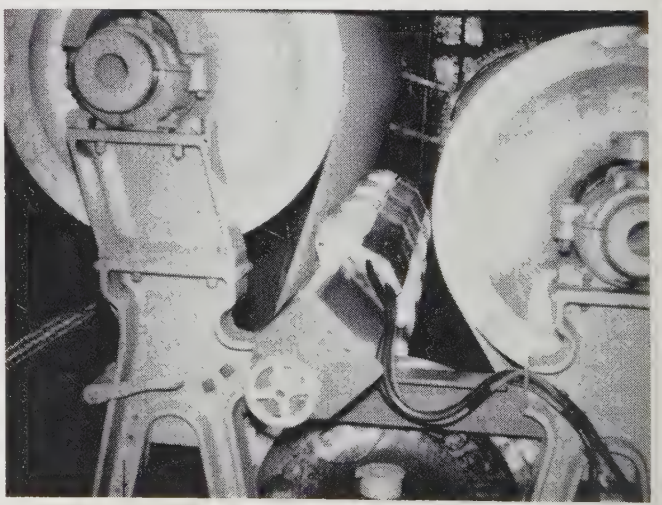
Essentially, the Hurletron system consists of a pilot drier, four moisture gages, and a control cabinet. The pilot drier, which is the last drier on the machine, is isolated from the other driers and maintained at a constant temperature. Steam is supplied to this drier at precisely 23 p.s.i. through a Leslie pressure-reducing valve, and the condensate is exhausted to the atmosphere. This latter point is a precautionary measure to eliminate any variation that could be caused by back pressure.

Each moisture gage consists of two heat-sensitive heads enclosing five copper-constantan thermocouples wired in series. One head with a copper wear strip $^3/_{16}$ in. thick, 1 in. wide, and 5 in. long rides against the pilot drier to measure its surface temperature, while the other head, having a stainless steel wear strip of the same dimensions, contacts the sheet at a point approximately 30 in. from the reference drier. A complete measuring element is made up of two heads placed in tandem and wired together in series opposing, to produce voltages exactly related to the temperature differential. This voltage is impressed on a 0–8 mv. instrument calibrated 0–100.

The four moisture gages are approximately 20 in. apart from one another. Mounted on a crossbeam, they can be moved laterally to scan the entire web for wet streaks (Fig. 1). The wear strips on the heads serve a dual purpose: they protect the thermocouple, and they restrict the response of each variation of moisture.

The control cabinet (Fig. 2) is located at the dry end of the machine, where it can easily be observed by the operating personnel. It comprises two instruments: the top instrument records the moisture at the controlling head, the set point, the steam pressure, and whether the system is on automatic or manual control. When the moisture deviates from the set point, a pneumatic signal is sent to a standard Foxboro air-to-open valve which regulates the steam in the controlled drier section in accordance with the amount of deviation. This instrument is equipped with adjustable proportional band, automatic reset, and derivative action.

The lower instrument, an electric multipoint type, records the moisture at all four gage positions. This enables the operator to locate quickly the wettest por-



Courtesy of Electric Eye Equipment Co.

Fig. 1. Moisture gages in control position

Thomas M. Keville, Jr., Assistant to the Superintendent, Continental Can Co., Inc., Robert Gair Paper Products Group, Elkhart, Ind.

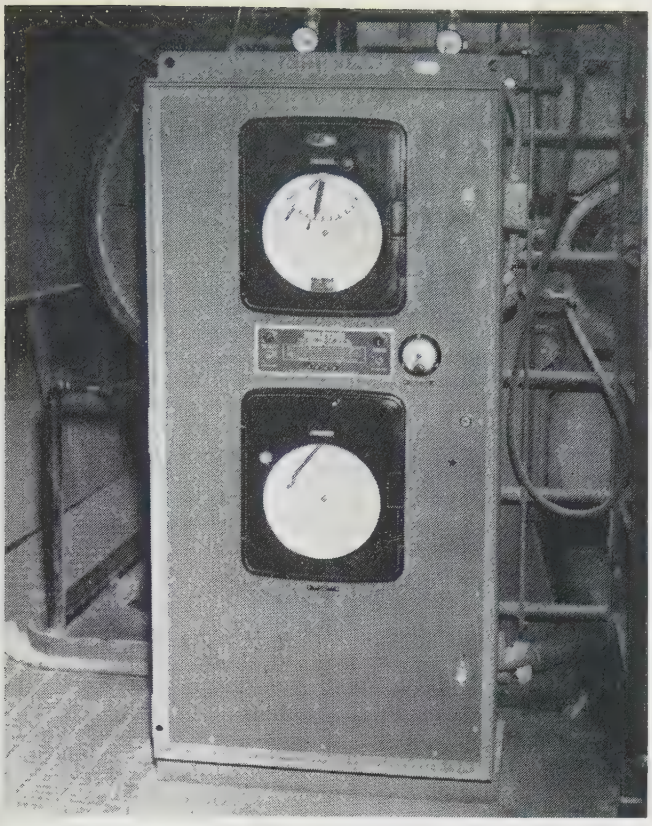


Fig. 2. Hurletron control cabinet

tion of the sheet without hand-sampling. The gage indicating the highest moisture is always selected as the controlling head. A push-button arrangement allows the operator to change from one controlling head to another.

An additional feature of the Hurletron system is an automatic break control. When the sheet is broken, a preset pressure is applied to the controlled drier section. This pressure is maintained until the sheet is fed into the wet stack, at which time the unit returns to automatic control (*1*).

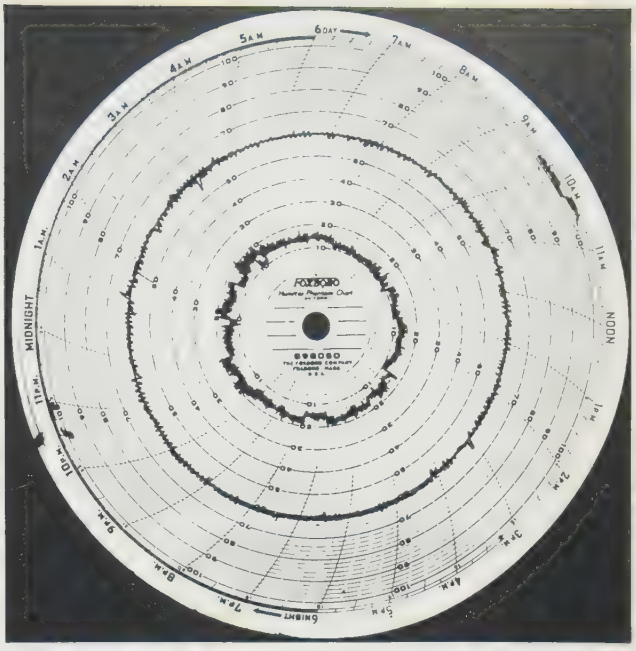


Fig. 4. Hurletron automatic control

OPERATIONAL EXPERIENCE

Tests were made to determine the reproducibility of the Hurletron set points and to find how these points were related to the moisture content of the sheet after the drier section. A series of test samples were cut out directly after the controlling head, and the moisture reading of the instrument recorded. The samples were then dried and the moisture loss calculated. It was found that there was little difference, if any, between grade of board, caliper, and moisture at a given reading. For example, if a reading of 50 on a clay-coated sheet was $2^1/_2\%$, a white-lined kraft would be $2^1/_2\%$ at that reading.

Usually we will run our board at a set point of 50 to 60 which, from the preceding test results, is somewhere in the 2.5 to 3.5% moisture range. On coated grades

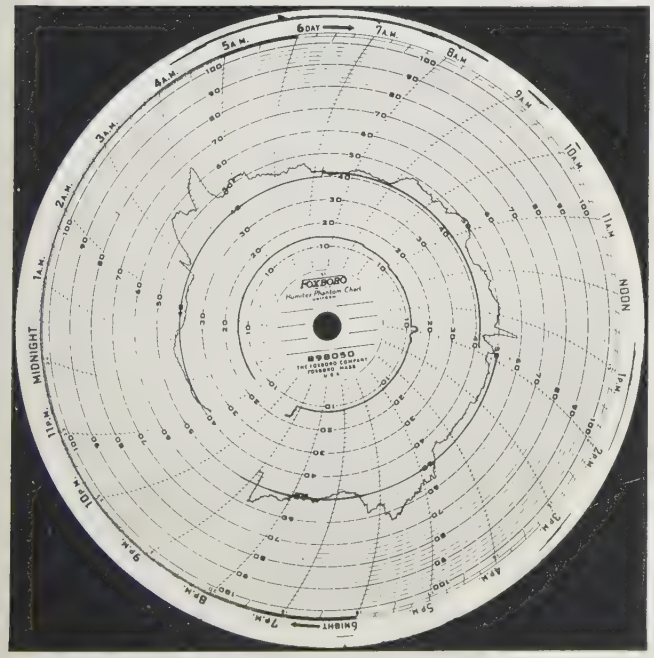


Fig. 3. Drying by manual control

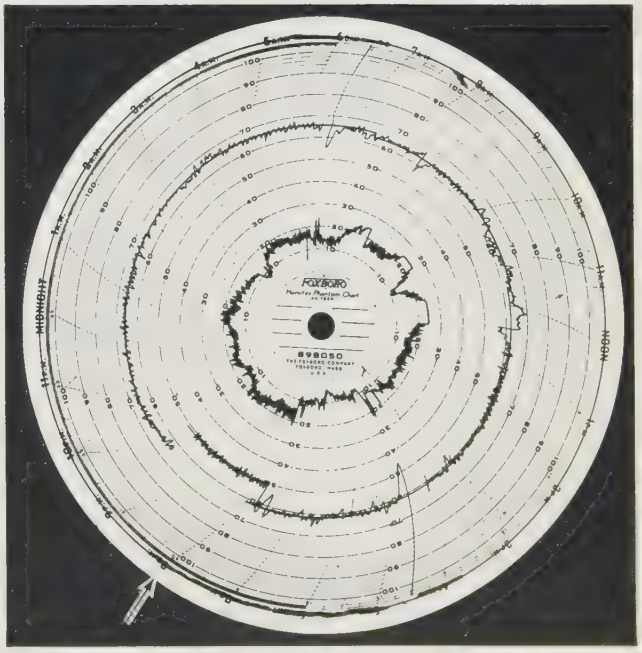


Fig. 5. Set point adjustment for coated grade (8:00 P.M.)

it is in the lower region, whereas on uncoated sheets it will be higher, sometimes entering the mid-60's. This is all related to drop-box moisture, which is held between $5^1/_2$ and $7^1/_2\%$. The treatment at the calenders was the deciding factor in the selecting of a set point on uncoated grades; whereas calender treatment, amount of coating, and oven temperature dictated the setting on coated board.

On different runs of the same grade of board, however, it was found that the set points had a tendency to repeat themselves. This has been a tremendous aid in reducing waste during changes.

During a run the stock may come heavy or light, slow or free, or the machine tender may alter the weights on the presses. These are but a few of the many factors that influence the moisture content of a sheet. The Hurletron gages will sense any such change and immediately act to correct it by sending a voltage signal to the controller. The controller, in turn, regulates the air acting on the steam control valve to put on or shut off steam. As a result the moisture is controlled to $\pm^1/_2\%$ after the last dryer. Figure 3 shows the system on manual control. Note the moisture variation and compare to Fig. 4, which is on automatic control. Sometimes, however, the moisture variation may be so great that the steam control valve will be wide open or be completely shut. When this occurs, a red or green light, respectively, flashes on the control panel to make the condition known to the backtender.

If you are fortunate enough to have a long run of board of the same grade, the Hurletron seldom requires a set point adjustment. Minor caliper changes within the same grade will not affect it. On a four-point change or more, however, the backtender will lower the set point to allow the driers to come up to temperature while the change is in progress at the wet end. This reduces waste on the change due to wet board. After the machine has settled down, the set point is returned to its original position.

A grade change is handled in the same fashion. The set point is lowered when changing from an uncoated to a coated sheet. When the change is from coated to uncoated, the set point will remain the same (Fig. 5). On runs of 2-hr. duration or more, the Hurletron does a fine job of controlling minor variations. On shorter runs its full use tends to be limited because of the need for hand operation.

When the instrument was first installed, the personnel were thoroughly briefed on its operation. They remained skeptical at first, and more or less insisted in running the set point below the moisture indicator so that maximum steam pressure would remain on. This stemmed from a fear of wet board and the former habit of overdrying. Within a few weeks they gradually developed confidence in themselves and in the instrument and began to operate it properly. There was a noticeable improvement in sheet finish and bender.

Records based on a year's operation show a decrease in steam consumption of approximately 9%. There was no noticeable increase in the overall moisture content of the finished sheet. The Hurletron moisture has made possible a more uniform moisture content with a reduction of off-quality paperboard due to high moisture.

We have experienced little maintenance costs. Shortly after the installation of the unit we instituted a weekly check into the condition of the electronic tubes and have replaced only two tubes in a year of operation. We have since done away with this practice because weak tubes are quickly detected, with the instrument commencing a hunting process for the set point.

SUMMARY

The Hurletron moisture control system has given us the following:

1. A more uniform moisture content with a reduction in off-quality board due to high moisture.
2. An increase in off-the-drier moisture, as indicated by the 9% reduction in steam consumption. This factor most likely contributes to the better finish and bending properties that were observed.
3. Faster grade changes with less waste owing to the knowledge of set points for previous runs of the same grade.
4. A quick method of determining the moisture content of the sheet at the four head locations without hand-sampling. This is done by observing the multipoint instrument chart.
5. Low maintenance cost.

The controller has two limitations:

1. Only one head can be used to control the moisture. This head, being 5 in. long, represents only $5^1/_4\%$ of the total web. Any wet streak not falling within these 5 in. remains undetected.
2. Runs must be at least 2 hr. or more to obtain full benefit of automatic control. On shorter runs its use is limited because of the need for hand operation.

LITERATURE CITED

1. Smiley, W. O., *Tappi* 41, No. 12: 212A–216A (Dec., 1958).

Received Feb. 27, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Errata

Optical Studies on Molded Disks of Cellulose Acetate and Propionate

L. H. Sperling

Tappi 44, No. 4: 280 (April, 1961)

The Billmeyer method, as illustrated in Fig. 2 and mentioned on page 281 (col. 2, line 12) and page 282 (col. 1, line 24) should be a plot of $1/\tau(1/\lambda)^4$ vs. $(n/\lambda)^2$, and the values in Table IV should then read:

Time, min.	*Acetate*	*Propionate*
0.0	0.094	0.20
10	0.080	0.14

These values are somewhat closer to the predicted value of 0.1 μ. No other conclusion in the paper need be changed.

Sulfate-Reducing Bacteria, Their Production of Sulfide and Their Economic Importance

Robert L. Starkey

Tappi 44, No. 7: 493–496 (July, 1961)

On page 495, second column, last paragraph, line 8; the sentence beginning on line 8 should read—*Inhibition of* development of the bacteria...

ASSOCIATION NEWS AND EVENTS

National Conferences

1962

Forty-seventh Annual Meeting, Feb. 18–22, 1962, Commodore Hotel, New York, N. Y.

Thirteenth Coating Conference, May 14–16, 1962, Netherland-Hilton Hotel, Cincinnati, Ohio.

Thirteenth Testing Conference, Sept. 18–20, 1962, Benjamin Franklin Hotel, Philadelphia, Pa.

Seventeenth Plastics-Paper Conference, Oct. 8–11, 1962, Statler-Hilton Hotel, Boston, Mass.

Seventeenth Engineering Conference, Oct. 14–19, 1962, Queen Elizabeth Hotel, Montreal, Que.

Twelfth Corrugated Containers Conference, Oct. 23–26, 1962, Statler-Hilton Hotel, Boston, Mass.

Sixteenth Alkaline Pulping Conference, Oct. 31, Nov. 1–2, 1962, DeSoto Hotel, Savannah, Ga.

1963

Fourteenth Coating Conference, May 19–22, 1963, Concord Hotel, Kiamesha Lake, N. Y.

Thirteenth Corrugated Containers Conference, Oct. 22–25, 1963, Statler-Hilton Hotel, Detroit, Mich.

Eighteenth Engineering Conference, Oct. 28–31, 1963, Netherland-Hilton Hotel, Cincinnati, Ohio.

1962 Annual Meeting, Technical Section Canadian Pulp and Paper Association

The 1962 Annual Meeting of the Technical Section, Canadian Pulp and Paper Association will take place at the Queen Elizabeth Hotel, Montreal, on the last Tuesday, Wednesday, Thursday and Friday of January, the 23, 24, 25, and 26. Sessions will begin at 2:00 p.m. on Tuesday and will end at noon on Friday; the Registration Desk will open at 9:00 a.m. on Tuesday. A products display will be held concurrently with the meeting.

Requests for accommodation should be addressed to Nelson Verge, Rooms Division Manager of the hotel. Give the date and time of your arrival, and tell the hotel if you are a member of the Technical Section. The Technical Section does *not* handle room reservations.

Anyone wishing to present a paper at this meeting should contact Douglas Jones, Executive Secretary, Technical Section, Canadian Pulp and Paper Association, 2280 Sun Life Building, Montreal 2, Que., at an early date.

Career Booklets

A second printing of 100,000 copies of the booklet, "Grow with an Exciting Business," is now available to industry members from the Paper Industry Career Guidance Committee. The booklet encourages junior and senior high school students to continue their education by portraying the challenging and rewarding careers waiting them in the paper industry.

A list of companies providing scholarship assistance and the schools which have specialized courses in pulp and paper technology is contained in the booklet.

"Grow with an Exciting Business" was first issued in 1960 by the Career Guidance Committee, an organization which represents all segments of the industry through five associations. Nearly 50,000 copies of this printing have been sold to companies for local school use.

Prices of the new edition have been reduced. The cost is 15¢ per copy in quantities up to 500 and 10¢ per copy for quantities over 500. Orders for the booklet may be sent to the Paper Industry Career Guidance Committee, 122 E. 42nd St., New York 17, N. Y.

The booklet has been expanded to include a more complete listing of companies providing financial aid available to students. There is also a fuller description of scientific, technical, and marketing opportunities in the industry.

Walter B. Morehouse, chairman of the Career Guidance Committee and vice-president, Nopco Chemical Co., stated that the career booklet will help meet the industry's rising demand for trained personnel by acquainting youngsters with the exciting career potential offered by the paper industry. He said that stepped-up distribution of the booklet by industry members is a sound investment in the future growth and health of paper, paperboard and allied industries.

Copies of "Grow with an Exciting Business" have been distributed to students as part of company-sponsored plant tour programs, and through career day seminars and business-education day observances. It has also been given by companies to teachers and guidance leaders for classroom distribution and discussion.

The booklet can be used as supplement to other educational material supplied to students in a company community relations program. For many suppliers and smaller units in the industry, the booklet has provided the opportunity to initiate a low-cost but effective career guidance program.

Data Sheet Withdrawal Notice

The following Data Sheets have been reviewed by the responsible Committees and Divisions and, as a consequence, have been withdrawn because the information is obsolete, erroneous, or no longer practical.

Data Sheet number	*Title*
4 A–4 B, inclusive	Centrifugal Pump Characteristics
31	Castor Oil Temperature—Viscosity Corrections
39	Welding Electrode Requirements
77	Determination of 54-Gallon Drum Content
90-D–90-G, inclusive	Protective Treatment for Concrete
93, 93-B, 93-G	Heat Insulation
96	Paper Machine Preventive Maintenance
114	Length of Paper in Roll
140	Lead Service Pipe

Attention Authors

47th Annual Meeting

Deadline for Abstracts and Manuscripts January 1, 1962

Twelfth Testing Conference

The Twelfth Testing Conference of the Technical Association of the Pulp and Paper Industry was held Aug. 15–17, 1961, at the Queen Elizabeth Hotel, Montreal, Que. This conference, an annual function of the TAPPI Testing Division, was cosponsored by the Technical Section, Canadian Pulp and Paper Association. C. E. Brandon, Miami University, Oxford, Ohio, retired as general chairman of the TAPPI Testing Division and was succeeded by H. A. Smith, The Mead Corp., Chillicothe Division.

The conference was planned by the following joint CPPA-TAPPI committee:

W. O. Kroeschell, General Conference Chairman, Michigan Carton Co., Battle Creek, Mich.
J. E. Tasman, Program Chairman, Pulp & Paper Research Institute of Canada, Montreal, Que.
R. A. Joss, Local Arrangements Chairman, Technical Section, C.P.P.A., Montreal, Que.
W. F. Bachelder, Exhibits Chairman, Testing Machines, Inc., Mineola, L. I., N. Y.

In the following account, brief abstracts of the paper are given. The full text of all the papers presented will appear in various issues of *Tappi*.

Outstanding features of the three-day meeting were a symposium on International Standardization and a technical session completely devoted to newsprint testing.

Lennart Stockman, director of The Central Laboratories of the Swedish Cellulose Industry, discussed the SCAN methods and their adoption by the Scandinavian countries.

Also featured in the symposium on International Standardization was Miss Karin Wilson, chairman of ICCA, who spoke on the program and achievements of ICCA. ICCA held its annual meeting in Montreal on Monday, August 14, immediately prior to the Testing Conference. Waldemar Jensen, managing director of the Finnish Pulp and Paper Research Institute told of the organizations active in the field of international standardization of pulp and paper analysis and testing. Robert B. Hobbs, chief, Paper Section of the National Bureau of Standards, who is also chairman of the U. S. Advisory Committee for Technical Committee 6 of the International Standardization Organization was moderator of the symposium.

The technical program, as developed by J. E. Tasman, Pulp and Paper Research Institute of Canada, Montreal, Que., was as follows:

On Tuesday, Aug. 15, 1961, a Physical Testing Session was held with N. G. M. Tuck, Howard Smith Paper Mills, Ltd., as chairman. W. O. Kroeschell, general conference chairman opened the technical conference and F. L. Mitchell, general manager of the Canadian Pulp and Paper Association welcomed the delegates. The following papers were then presented.

Physical Testing Session

"Improved Techniques for Determining Particle Size by Means of the Electron Microscope," by Igor Karpenko, Richard W. Dye, and William H. Engel.

Techniques were developed whereby the inherent disadvantages of microscope evaluations of the size of submicron pigment particles were minimized. These techniques were developed for the electron microscope and, in particular, for the evaluation of the "crystallite" size of anatase and rutile titanium dioxide pigments. Crystallites, the objects measured, may be distinguished from aggregates according to a broad classification based on appearance and size. The improved techniques for evaluating crystallite size were achieved primarily through the use of a miniature vibratory ball mill which was developed for the rapid and effective deaggregation of the pigment to the crystallite state, and the use of a Zeiss particle size analyzer for the rapid, semiautomatic measurement of crystallite diameters. Reliable data can be obtained in a relatively short time from the measurement of only 750 crystallite diameters. Excellent precision is indicated by replicate studies. It is believed that the techniques employed might apply equally well to pigments other than titanium dioxide.

N. G. M. Tuck, Igaor Karpenko, Richard W. Dye, W. H. Engel, William R. Willets, John J. Lane, K. W. Ninnemann, C. H. Mayhood, Jr., O. J. Kallmes, James d'A. Clark. Physical Testing Session, Tuesday, Aug. 15, 1961

"Water Vapor Transfer through Multiple Barriers," by K. W. Ninnemann and L. E. Simerl, Film Operations, Packaging Div., Olin Mathieson Chemical Corp., New Haven 4, Conn.

A packaging material must fulfill certain general requirements in order to be considered satisfactory in its intended application. For example, it must have enough strength to contain the product being packaged, in some instances over a wide range of temperatures, possibly for long periods of time; it must protect the product from losing moisture—or the opposite, gaining moisture; it must seal well, whether by the application of adhesives or by heat sealing; and it certainly must handle well on packaging machines.

All of these functional properties are important, but we believe the ability of the material to resist the passage of water vapor through it, that is, the water vapor transmission or permeability characteristic, leads in importance. Desirable water vapor transmission rate may cover a wide range of values. Some applications require extremely low transmission rates to maintain the moisture content of the product, such as tobacco in the case of cigarette wraps; others, notably fresh fruit, vegetables and some processed meats, require a relatively high transmission rate to avoid condensed water droplets in which fungi or other microorganisms may grow, and thereby prolong shelf life. The presence of undesired water vapor in a package may result in hydration, sliming, fogginess of the packaging material and even contamination of flavor. Conversely but equally important from the standpoint of product protection, the loss of water vapor will cause dehydration as may happen with baked goods.

Since we are concerned with the problem of water vapor permeability or impermeability, the question immediately arises as to how packaging materials will best provide the desired level of protection: singly, or in combination, and if in combination, in what order. In this article we will discuss principally the effect of multiple layers of similar or different materials and the sequence of the different materials in the multiple layer on the rate of water vapor transmission.

"Some Notes on the Dispersant Requirements of Titanium Dioxide," by William R. Willets and John J. Lane, Titanium Pigment Corp., New York, N. Y.

It is frequently valuable to know the optimum amount of dispersant to produce high total solids water slurries of ti

HORSE HEAD PRODUCTS (R)

FLOW at 70% solids.. EXCELLENT!

Horse Head® A-440 TITANIUM DIOXIDE

That's what papermakers tell us about the new Horse Head A-440 anatase titanium dioxide. Its low viscosity permits the production of free-flowing coating colors of high solids content with a minimum of dispersant. This tailor-made titanium dioxide is free of agglomerates to give quick and complete dispersion — to reduce mixing time.

Horse Head A-440 will enable you to make better coating colors — faster — with production savings.

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 38, N. Y.

Founded 1848

Also distributed by BULKLEY DUNTON PULP CO. INC. • New York, N. Y. • Kalamazoo, Mich. • San Francisco, Calif.

Head Table at Official Luncheon, Thursday, Aug. 17, 1961, A. J. Winchester, J. E. Tassman, C. E. Brandon, D. Jones, H. A. Smith, H. A. Spencer, and L. R. Thiesmeyer

tanium dioxide. The use of too little dispersant results in a pasty slurry while overdosage produces flocculation which is detrimental to the development of optimum optical properties and may cause an increase in viscosity sufficient to affect milling and handling of the slurry adversely. A simple and quick method of determining the optimum amount of dispersant is based on the use of a paint conditioner (shaking device) as the primary method of mixing. Small increments of the dispersant are added as a concentrated solution and the viscosity determined using a Brookfield Synchro-lectric viscometer at each level of addition. The optimum dispersant is the amount which produces the minimum viscosity. The optimum (expressed as a percentage based on the pigment) is governed by certain factors such as the total solids of the slurry and the water hardness. Curves demonstrating the effect of such factors for a rutile pigment are given, as well as curves showing marked differences among three grades of anatase being sold principally for paper coating. The simple procedure described has a great many practical applications because the use of the optimum amount of a dispersant rather than an arbitrary amount under any given set of conditions results in greater efficiency and economy. It also provides a means of predetermining operable solids, for ascertaining the best dispersant to use under a given set of conditions, and of selecting the pigment which will produce the highest total solid slurry with a minimum of dispersant.

"The Mechanical Properties of Paper. II. The Shear Strength of Individual Fiber-Fiber Bonds," by C. H. Mayhood, Jr., O. J. Kallmes, and M. M. Cauley, St. Regis Paper Co., Technical Division.

The mechanical properties of paper depend upon the mechanical properties of the fibers, their arrangement in the sheet, and the number and strength of the interfiber bonds. It has been observed that the application of a tensile force to paper causes, among other phenomena, numerous fiber-fiber junctions to fail in shear. An instrument has been built to measure the shear stress of individual fiber-fiber bonds at the failure load. The apparatus and experimental techniques are described. The results agree well with the average failure load (in shear) per interfiber crossing calculated from the geometry of the rupture zone and the failure load of handsheet samples.

"Weight Average Fiber Lengths—A New, Quick, Visual Method," by James d'A. Clark.

A new, rapid method for measuring the weighted average fiber length weighted by length comprises placing the fibers into only six or seven length classes. This was accomplished with a 6-in. circumference tracing wheel with inch divisions for tracing the fiber images magnified 25.4 times, and in a further step, simplified by merely counting the number of 1-in. square grid lines which the images cross. The theory of the procedures is discussed including precautions for securing a proper representation of the fibers in the fields examined.

The relationship between weight per unit length of fiber and their lengths has also been measured for the TAPPI reference sulfite pulp. An S-shaped curve results; the coarseness varying from about 14 dg. for 1-mm. fibers to 27 dg. for 4-mm. fibers. Knowing this relationship, which may be a fairly general one for coniferous wood fibers, the weighted average fiber length by weight of a sample can be calculated provided that the percentage by weight of debris in the sample is known. In the case of a classified fraction of a pulp, no debris is present and the weight average length can be estimated with accuracy.

On Wednesday morning, August 16, twin sessions were held. A. D. Hamilton, The Ontario Paper Co., was chairman of the Newsprint Testing Session and W. K. Wilson was chairman of the Chemical Testing Session. The following papers were presented:

Newsprint Testing Session

"Newsprint Quality Control," by Vincent N. DeFelice, Control Superintendent, St. Croix Paper Co., Woodland, Me.

The problems of newsprint quality control are discussed, followed by a description of the newsprint quality control program at St. Croix Paper Co. and some thoughts and hopes for the future.

The objective of newsprint quality control is to provide uniform paper at low cost which will run well and print well in a newspaper pressroom and provide a suitable medium for display of printed matter and photographs.

As newsprint is mass-produced on high-speed machines, newsprint quality control must also be geared to high speed. Unfortunately there are many problems which prevent this ideal from being reached. These include: (1) sampling, (2) testing, (3) specifications, (4) use of test results, and (5) lack of good instrumentation.

"The Physical Properties and Pressroom Running Performance of Newsprint Paper," by Gerard Larocque.

Physical measurements made on newsprint samples taken from rolls which broke while running in a newspaper printing press, as compared to rolls which gave a satisfactory performance, have disclosed that certain lots of newsprint failed because of thin areas or irregularities of sheet formation. In other instances, pressroom failure was associated with either a low moisture content of a low resistance to tear. A majority of these breaks occur at the point where the web unwinds in the reel stand. These breaks are believed to result from shock waves, in the web, produced at this point.

It is suggested, therefore, that a more elastic or stretchable newsprint would be of significant benefit to the industry. In order to further the development of such a sheet, there is need of a simple instrument which would be capable of measuring the percentage elongation of paper, at rupture, under conditions more nearly similar to those existing in the pressroom, namely: A 3-in. strip, a fixed load, and a loading rate of 7 cp.

ATLAC® 382

GLASS REINFORCED PLASTIC

corrosion resistant construction material for pulp and paper mill equipment

Where corrosion takes too great a toll—in tanks, ducts, fume hoods, chests, vapor condensers (and similar equipment)—you and your fabricator should take a good look at glass reinforced ATLAC 382 bisphenol polyester resin. It offers seven distinct advantages in pulp and paper mill operations as a construction material:

1 **Corrosion resistance** ATLAC 382 is virtually immune to the bleaches, acids, salts and alkalis used in paper making—at temperatures below 250°F. One example: a 4,400-gallon tank of ATLAC 382 is still in mint condition after two years of alternately storing 14% sodium hypochlorite and caustic soda.

2 **High strength** Pound for pound, reinforced ATLAC 382 is stronger than steel. You get the same total strength with less total weight. Examples: 30,000-gallon tanks of ATLAC 382 are completely self-supporting...and even the largest hoods need no corrosion-prone metal bracing.

3 **Light weight** Equipment of ATLAC 382 is generally lighter than wood, Transite, or metal equipment. In one case, a 1,000-gallon tank of ¼" ATLAC 382 weighed 300 pounds, compared with 4.3 times that weight for alloy steel.

4 **Economy** ATLAC 382 equipment generally costs one-half to one-third less than rubber-lined or tiled equipment, and is normally equal to 304 and lower in price than 316 stainless steel. It is almost always a better buy than the more exotic metals if temperatures and pressures are not too high.

5 **Design flexibility** There are very few practical limits in size and shape for equipment of ATLAC 382. What's more, equipment can sometimes be redesigned to take advantage of ATLAC 382's unique structural characteristics—resulting in extra simplification, practicality and cost reduction.

6 **Easy installation** Because of reinforced ATLAC 382's light weight, relatively few men are needed to install it. Also, since it can be joined right on the plant floor, large equipment can be shipped in sections and field-erected. Equipment is readily changed and modified. Ducting can be relocated and reassembled without special equipment or personnel.

7 **Low maintenance** ATLAC 382 equipment needs virtually no periodic maintenance. It never needs painting or rust removal, always looks clean and attractive. Physical damage is easy to repair generally without down-time.

But why not get the feel of ATLAC 382 for yourself? Let us send you details on ATLAC 382, its uses in the pulp and paper industry, and a comparison of the corrosion resistance of various reinforced plastics. At the same time, we'll be glad to supply a test sample so you can prove to your own satisfaction that ATLAC 382 is well worth considering. For your sample—and data on ATLAC 382—mail the coupon, or write Atlas direct.

Atlas Chemical Industries, Inc
Wilmington 99, Delaware

Please send details on ATLAS 382, and a free test sample.

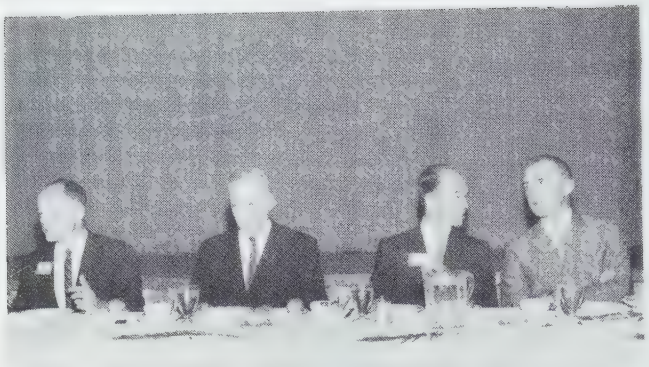
NAME ..... TITLE .....

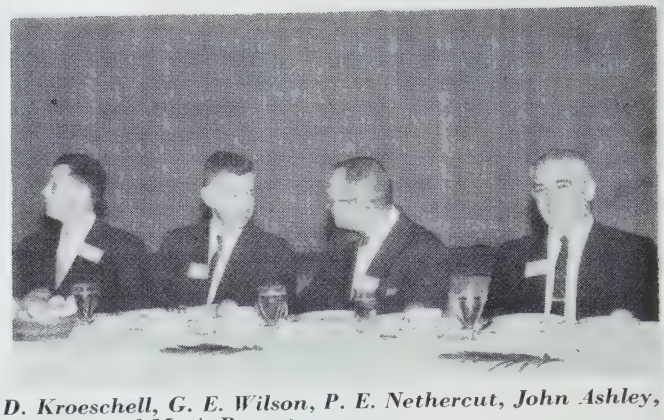
COMPANY ....

ADDRESS ....

CITY ..... ZONE ..... STATE ....

ATLAS CHEMICAL INDUSTRIES, INC.





Head Table at Official Luncheon, Thursday, Aug. 17, 1961, W. D. Kroeschell, G. E. Wilson, P. E. Nethercut, John Ashley, R. B. Hobbs, R. A. Joss, W. F. Bachelder, and M. A. Burnston

"The Formation of Newsprint as Related to its Printability," by CHARLES A. SANKEY, The Ontario Paper Co., Ltd., and LLOYD E. FOSS, ANPARI.

The development of new testing methods for newsprint to give information specifically pertinent to its printing quality and, in general, the correlation of newsprint properties with its printability is of increasing importance. In this connection the significance of the structure of newsprint (with especial reference to its uniformity and the presence or absence of markings) to its printing quality has long been recognized in the purely subjective sense so that experienced papermakers and printers seldom fail, in examining a sheet of newsprint, to look through it and so judge its "formation."

The development of the QNSM formation tester (Burkhard, Wrist, and Mounce, *Pulp & Paper Mag. Can.* 61, T-319–T-344 (June, 1960)) which provides a measure of paper structure by means of a graphical spectrum showing floc separations, in the machine and cross directions, respectively, from 4 to 0.013 in., permits a more quantitative and less subjective approach to a study of printability-formation correlation. The American Newspaper Publishers Association Research Institute undertook a broad program of newsprint evaluation in 1959, this program being primarily directed to newsprint evaluation as a medium for printing. The opportunity on the one hand to develop the significance of the formation measurements available with the QNSM tester and on the other to establish whether information could be obtained pertinent to the printability of newsprint led to a mutual interest of The Ontario Paper Co., Ltd. and the ANPA. Through the facilities of the ANPA-RI it was possible to examine a wide range of coded newsprint samples from many different manufacturers and many different pressrooms for a broad independent appraisal.

It is fully recognized that the only ultimate test of printability of newsprint is in the final commercially printed form. Of necessity the ANPA program had to be based on a laboratory scale investigation for which a particular proof press evaluation was employed (A. S. Taylor, *Tappi* 43: 237A–242A (April, 1960)). The present study, therefore, started with obtaining a formation curve on a given area of newsprint, which specific area was later proof press printed. The structure of this print was then examined on the formation tester and correlated with the structure of the paper and this comparison in turn correlated to the other test data available at the ANPA-RI, especially its standardized proof press evaluation. The limitations in this comparison have become apparent and are instructive in considering the basic problem of the influence of paper structure on printability. An attempt is made to interpret and explain this correlation beyond the limits imposed by laboratory techniques.

The principal conclusions are that the wire mark index as measured by the QNSM tester has a strong correlation with printability and accounts for a significant percentage of the overall effect of newsprint quality on printing. It is further concluded that the correlation of newsprint formation and printing is primarily a matter of detailed structure. It is in this sense that wire mark as well as structure "abnomalities" such as streaks, felt marks, press marks, and like discontinuities are important. For newsprint, the pertinent structural description required appears to be a matter of detail and not of overall average generalities.

Chemical Testing Session

"Flame Photometry as an Analytical Technique," by C. S. JOYCE, Pulp and Paper Research Institute of Canada.

By means of improved techniques, as many as 60 elements can be energized in the flame, and caused to re-emit this energy at characteristic wavelengths, which can be detected and measured.

A study has been made of some of the important factors which influence the excitation and detection of certain elements present in plant tissue. Potential applications of this technique are suggested.

"The Examination of Boxboard Samples for Trace Quantities of Heavy Metals," by WALTER F. WEISS and EDWARD C. STIVERS, Arthur D. Little, Inc.

An analytical examination for trace quantities of mercury, lead, cadmium, antimony, and arsenic in samples of food grade-commercial boxboard is described. A digestion scheme using sequentially nitric and perchloric acids was used at moderate temperatures so as to avoid the loss of mercury. The digestion solution was then treated with various colorimetric reagents for the final metal determinations.

Lead was found to be present at the level of 3 p.p.m. with an order of magnitude less of mercury, antimony, and cadmium. The presence of arsenic could not be detected.

"The Variability of Ash Determinations with Paper Sample Size," by LEWIS T. MILLIKEN, U. S. National Bureau of Standards.

Most analyses of paper are intended to characterize fairly large lots. In certain cases, normal sample sizes exceed the quantity of paper available for analysis. In the case of analytical filter papers, a convenient quantity for analysis requires several individual sheets and can conceal important sample-to-sample variability. Localization of mineral fillers in filled sheets can affect useful paper properties.

The reduction of paper sample size to the minimums now permitted by convenient semimicro techniques reveals variations not previously detected.

The variability of ash values in a mineral loaded paper, an unloaded paper, and an acid-washed paper is shown to increase sharply below a critical sample size characteristic of the particular paper.

"Defining and Solving Toxicological Problems Related to the Paper and Pulp Industry by Use of Radioisotope Techniques," by F. J. DOMINGUES, General Measurements, Inc.

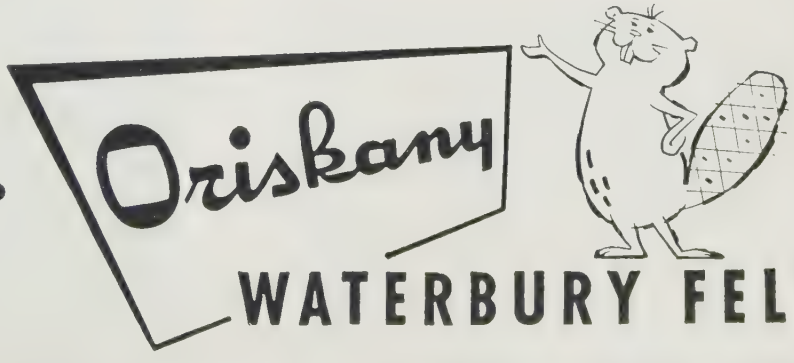
The paper illustrates (1) how isotopes can determine whether a problem exists or not as indicated by the BHT transfer

ORISKANY'S Laboratory Testing Service helps you prolong felt life...produce better paper products

In our laboratory at Oriskany, we have designed special equipment to test cross strips of your felt and determine whether your press rolls are causing uneven wear. Our technicians can check for bacterial damage or chemical deterioration and recommend one of our exclusive treatments to combat unusual conditions. Each special felt design is subjected to careful tests for finish, drainage and fiber strength.

If you have an unusual felt problem, one of our competent Service Engineers will visit your mill and make a thorough investigation. He can often make 'on-the-spot' recommendations that will correct the condition, or he will report his findings to our technical staff. Their combined experience is at your service to help you produce better paper products . . . at lower cost.

Domestically owned and operated since 1869



WATERBURY FELTS

H. WATERBURY and SONS COMPANY • ORISKANY, NEW YORK

Newsprint Testing Session, Wednesday, Aug. 16, 1961, Chairman A. D. Hamilton, Vincent N. De Felice, Gerard Larocque, Charles A. Sankey, Lloyd E. Foss

studies in packaging materials and (2) how direct metabolism studies can afford supplementary information to the usual toxicity program and, in certain specific cases, substitutes for such a program. Also discussed is the newer approach to rapid assessment of toxicity, using isotopes as indicators of when normal metabolism has been interfered with by the addition of foreign additives to a normal dietary regime.

Symposium on International Standardization

On Thursday, Aug. 17, 1961, a Standardization Symposium was held with R. B. Hobbs, U. S. National Bureau of Standards, as moderator. The following papers were presented:

"Organization Active in the Field of Pulp and Paper Analysis," by W. Jensen, Finnish Pulp & Paper Research Institute.

The paper surveys the organizations which are active in the field of "The Analysis and Testing of Pulp and Paper." In order to eliminate the obstacles which stand in the way of a general appraisal of the international methods of analysis it is necessary to gain some comprehension of the functions fulfilled by these organizations and the work in which they are engaged.

"International Committee on Cellulose Analysis," by Miss K. Wilson, Uddeholms, AB Sweden.

The International Committee for Cellulose Analysis, or ICCA for short, is a committee working with the testing of chemicals and semichemical pulp but not with paper and board. This paper presents the history, development, and activities of ICCA.

"The "SCAN" Methods," by L. G. Stockman, Central Laboratory of the Swedish Cellulose Industry.

The paper reports on the new SCAN methods which are a development of the international cooperation of the Scandinavian countries, Norway, Sweden, Denmark, and Finland.

"The Interlaboratory Study as a Step in the International Standardization of a Method of Measurement," by T. W. Lashof, U. S. National Bureau of Standards.

A simple mathematical model of the measuring process is developed. The purpose of standardization is discussed in terms of this model. Emphasis is given to the place of the interlaboratory study in evaluating the need for better standardization and indicating the direction such standardization should take.

Application of the mathematical model is illustrated in terms of the recent American study of the Blemendorf method for internal tearing strength of paper, the Bekk smoothness method, and an ISO study of methods for natural rubber.

Exhibits

The attendees at the conference had the opportunity to view new and interesting instruments which were on display at an exhibit. Both Canadian and United States firms were represented and several new instruments attracted considerable attention. W. F. Bachelder of Testing Machines, Inc., was exhibits chairman of the conference.

Hunter Associates Laboratory featured their reflection meters incorporating new devices for ease of operation. The Emerson Apparatus Co. had on display their speed driers. At the William Apparatus Co. booth, a recording freeness tester attracted considerable attention. The Instron Engineering Corp. displayed the latest in electronic tensile testers and auxiliary equipment. Testing Machines, Inc. offered for viewing their slip and friction tester and new high-precision micro-profiler. The Robert Mitchell Co. of Montreal displayed for the first time their automatic handsheet press and also had on display the Canadian standard freeness tester. Measurement Engineering, Ltd. showed a wide variety of moisture indicating devices which, with attachments, can be used for moisture measurements in many different ways. The B. F. Perkins & Sons, Inc., has on display two types of mullen testers with power actuated clamps. At the Hughes-Owens Co., Ltd., booth, the Gurley instruments for paper testing and a new whiteness tester employing optical principles was of great interest. A recording pH meter and other simple and portable types of pH meters were on display at the Analytical Measurements, Inc., booth.

Mill Visits

On the day immediately following the conference, a mill visit was arranged to Rolland Paper Co., Ltd., at St. Jerome, Que. Conferees were also able to continue their visits to the Province of Quebec and to visit one or more mills in the Three Rivers area. Arrangements were made at the conference to visit the following mills:

St. Lawrence Corp., Ltd., Three Rivers, Que.
Canadian International Paper Co., Three Rivers, Que.
Consolidated Paper Corp., Ltd., at both Three Rivers and Grand'Mere, Que.

The feature trip of the conference was the new laboratories of the Pulp and Paper Research Institute of Canada at Pointe Claire, a suburb of Montreal. These laboratories were completed in 1958 and are a source of much of the excellent research in pulp and paper in Canada.

The entire laboratory was open to the 70 visitors who participated with guides at each location.

Outstanding features of this tour were: (1) scanning electron microscope and exhibit of photo micrographs taken with it; (2) instrument for measuring fiber flexibility based on point of rigidity of the fiber in rotating viscous fluid; (3) pulping and sheetmaking laboratories featuring a display of experiments on sheets with fibers highly oriented.

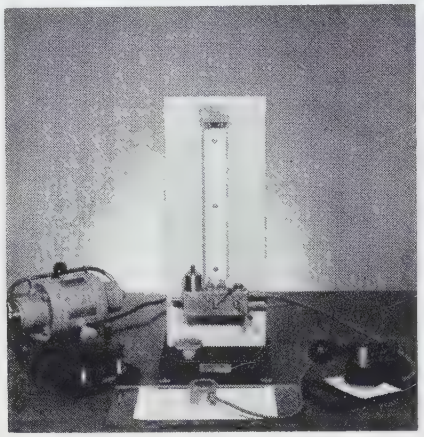
Technical Committee Meetings

Committees of the Testing Division held meetings, many jointly with the corresponding committee of the Technical Section of CPPA.

Chemical Testing Session, Wednesday, Aug. 16, 1961 Chairman W. K. Wilson, C. S. Joyce, Edward Stivers, Lewis T. Milliken, Frank J. Domingues

Christmas
Greetings 1961
1961 Christmas
Greetings 1961
Be sure your cards and
packages are signed, sealed
and delivered with
Christmas Seals
To Fight TB
ANSWER YOUR CHRISTMAS SEAL LETTER TODAY

THE
BENDTSEN TESTER
ONE LIGHTWEIGHT MACHINE THAT TESTS
PAPER AND PAPERBOARD
for
SMOOTHNESS . . . POROSITY . . . HARDNESS
Instantaneously

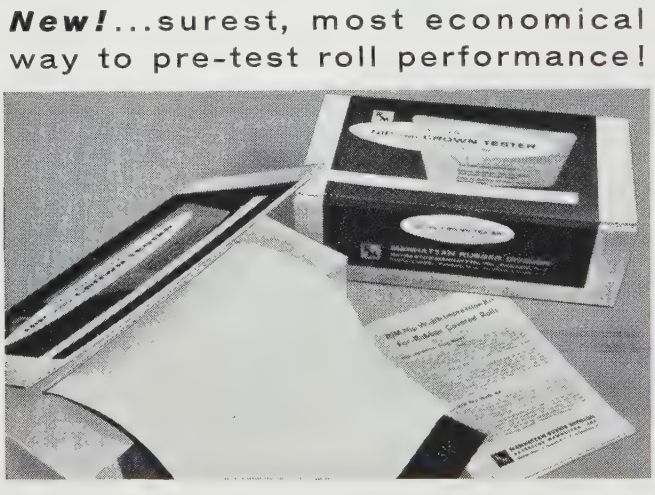


INSTANTANEOUS: No waiting—No scale adjustments.
ACCURATE: No oil or dust can enter instrument. Smoothness not effected by porosity.
VERSATILE: Completely self contained, portable, no special training required. Tests smoothness, porosity & printing hardness of paper & paperboard. Accessories available for Paperboard & Hardboard.

Write for details of our 30 day free trial offer and our new time saving three tube tester

Sole Distributors
ROBBINS INSTRUMENT CO., INC.
112 West 30 St., NEW YORK 1, N. Y.

New!...surest, most economical way to pre-test roll performance!



MANHATTAN
NIP and CROWN ROLL TESTER KIT

Specially developed carbon-and-master test sheet gives *accurate* record of nip and crown at pressures from 50-1500 lbs. per lineal inch. Assures top quality runs every time. Spots trouble before it starts! Prevents costly on-the-job failure. Reveals suction roll tendency to cup, flake, crack or corrugate. Test impression easily stored for complete roll service record.

Dispenser kit contains 200 ft. of test sheet. Complete instructions. **Valuable Crown Pamphlet** with complete instructions outlining use of Manhattan Crown Formula in connection with Nip Width Measurements. Order Now! RM 125

Roll Covering Plants at Passaic, N.J.— Neenah, Wisc.— N. Charleston, S.C.
RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

Symposium on Standardization: R. B. Hobbs, W. Jensen, Miss K. Wilson, L. G. Stockman, T. W. Lashof

The following TAPPI Testing Division Committees held meetings: Chemical Methods, Optical Methods, Precision, Release Paper Testing, Routine Control Methods, Wax Testing, Fillers and Pigments Testing, Paper Shipping Sack Testing, Paper Testing, Paperboard Testing, and Pulp Testing.

Annual Banquet

On Thursday afternoon, Aug. 17, 1961, the annual banquet of the Testing Division was held, with W. O. Kroeschell, General Conference chairman, acting as toastmaster. The banquet was jointly sponsored by CPPA and the 12th Testing Conference. Mr. Kroeschell introduced the head table guests and members of the conference committee, and called on H. A. Spencer, member of the TAPPI Executive Committee, who presented Certificates of Appreciation on behalf of H. M. Annis, TAPPI president, to R. S. Hunter, the retiring chairman of the Optical Methods Committee, and to W. R. Willets, retiring chairman of the Fillers and Pigments Testing Committee. Chairman Kroeschell then introduced the guest speaker, L. R. Thiesmeyer, president, Pulp and Paper Research Institute of Canada.

Mr. Thiesmeyer in his talk indicated that the future of the pulp and paper industry is extremely bright provided that it adopts new technologies. In order to compete with other industries, and to cut manufacturing costs, a technological revolution must take place. For this reason, he said, the pulp and paper industry is expanding its research support considerably.

Thirteenth Testing Conference

The 13th Testing Conference will be held Sept. 18–20, 1962, at the Benjamin Franklin Hotel, Philadelphia, Pa., under the general chairmanship of W. R. Willets, Titanium Pigment Corp., New York, N. Y. Miss J. M. Fetsko, Lehigh University, Bethlehem, Pa., is in charge of the technical program, the theme of which will be "Testing for the Graphic Arts." Anyone wishing to offer a paper for the conference should get in touch with Miss Fetsko without delay.

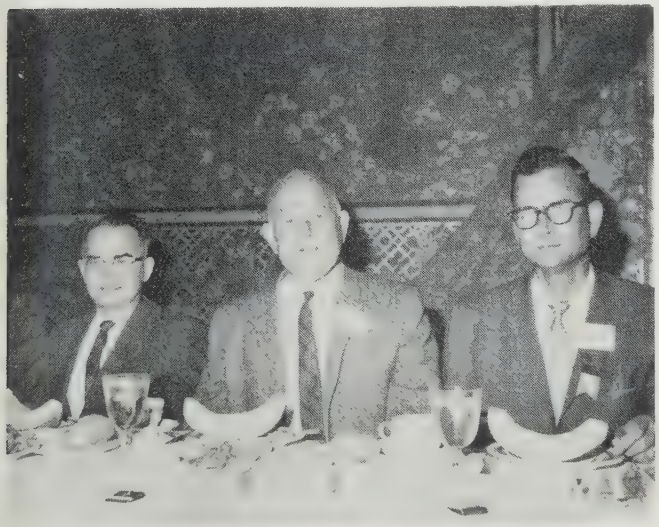
A TAPPI member is anxious to obtain a copy of the 1928–1935 Bibliography of Paper Making to complete his library. If you have one available please write to TAPPI, 360 Lexington Ave., New York 17, N. Y., stating price.

H. O. Teeple, TAPPI, New York, N. Y.; R. S. Owen, R. S. Owen & Co., Chicago, Ill.; H. E. Dunholter, Owens-Illinois Technical Center, Toledo, Ohio

L. F. Ashwood, Downing Box Co., Milwaukee, Wis.; G. M. Caploe, Longview Fibre Co., Oakland, Calif.; R. Wright, Philadelphia Quartz Co., Berkeley, Calif.

H. W. Wilson, Georgia Pacific Paper Co., San Francisco, Calif.; R. W. Buttery, Bathurst Containers, Ltd., Montreal, Que.; J. M. McEwan, Weyerhaeuser Timber Co., Everett, Wash.

A. J. Winchester, TAPPI, New York, N. Y.; J. J. Koenig, Crown Zellerbach Corp., St. Louis, Mo.; K. R. Martin, Olin Mathieson Chemical Corp., West Monroe, La.; O. P. Wanamaker, Fibreboard Paper Products Corp., Antioch, Calif.



H. T. Scordas, Union-Bag-Camp Paper Corp., New York, N. Y.; C. Dornbush, Georgia Pacific Paper Co., San Francisco, Calif.; A. Richardson, Crown Zellerbach Corp., San Francisco, Calif.

J. E. Knecht, Bathurst Power & Paper Co., Ltd., Whitby, Ont.; G. R. Wilmer, American Box Board Co., Grand Rapids, Mich.; A. L. Magnuson, Potlatch Forests, Inc., Lewiston, Idaho

J. M. McEwen, presenting retiring Chairman's Certificate to A. Richardson, Crown Zellerbach Corp.

J. M. McEwen presenting retiring Chairman's Certificate to G. R. Wilmer, American Box Board Co.

Session I: standing: H. E. Kulwicki, Koppers Co., Inc., Glenarm, Md.; D. Ward, Langston Co., Baltimore, Md.; A. F. Shields, S. & S. Corrugated Paper Machinery Co., Sunnyvale, Calif.; W. J. Hottendorf, H & C Container Machinery Corp., Sunnyvale, Calif.; seated O. P. Wanamaker, Fibreboard Paper Products Corp., Antioch, Calif.; R. W. Catzen, The Baltimore Paper Box Co., Baltimore, Md.; D. E. Tuttle, Interchemical Corp., New York, N. Y.

Session II: D. E. Tuttle, Interchemical Corp., New York, N. Y.; R. W. Catzen, The Baltimore Paper Box Co., Baltimore, Md.; W. J. Hottendorf, H & C Container Machinery Corp., Sunnyvale, Calif.; C. Dornbush Georgia Pacific Paper Co., San Francisco, Calif.; A. F. Shields, S. & S. Corrugated Paper Machinery Co., Sunnyvale, Calif.; D. Ward, Greenwood Engineering Div., Langston Co., Baltimore, Md.; H. E. Kulwicki, Koppers Co., Inc., Glenarm, Md.

Session III: standing: E. W. Carney, West Virginia Pulp and Paper Co., Torrance, Calif.; D. B. Phillips, Longview, Fibre Co., Longview, Wash.; R. Guillou, University of California, Davis, Calif.; seated: G. M. Caploe, Longview Fibre Co., Oakland, Calif.; O. P. Wanamaker, Fibreboard Paper Products Corp., Antioch, Calif.; D. S. Brown, Atlantic Refining Co., Philadelphia, Pa.

Standard Terminology: standing: L. F. Ashwood, Downing Box Co., Milwaukee, Wis.; A. L. Magnuson, Potlatch Forests, Inc., Lewiston, Idaho; R. S. Owen, R. S. Owen & Co., Chicago, Ill.; seated: R. W. Porter, Paperboard Packaging, Chicago, Ill.; R. W. Buttery, Bathurst Containers, Ltd., Montreal, Que.; H. E. Dunholter, Owens-Illinois Technical Center, Toledo, Ohio

Eleventh Corrugated Containers Conference

The Eleventh Corrugated Containers Conference was held Sept. 6–8, 1961, at the St. Francis Hotel in San Francisco, Calif. This was the first time the Corrugated Containers Division sponsored a conference on the West Coast. This most successful conference, attended by 307 men prominent in the corrugated industry, featured two sessions on flexographic printing. R. W. Catzen, Baltimore Paper Box Co., Baltimore, Md., was moderator of these two sessions. One session dealt primarily with the development of flexigraphic printing equipment, while the second dealt with the adaptation of flexographic printing to corrugated board. A feature of each session was an open discussion led by a panel of experts in each field.

One of the main reasons for holding the conference on the West Coast was to permit the registrants to obtain first-hand knowledge of the use of corrugated containers in agricultural applications. G. M. Caploe, Longview Fibre Co., Oakland, Calif., was moderator of this session which featured papers on the requirements for produce containers, their manufacture, and their testing.

The fourth session proved to be a most interesting one, which featured papers on new engineering developments. A. Richardson, Crown Zellerbach Corp., San Francisco, Calif., was chairman of this session.

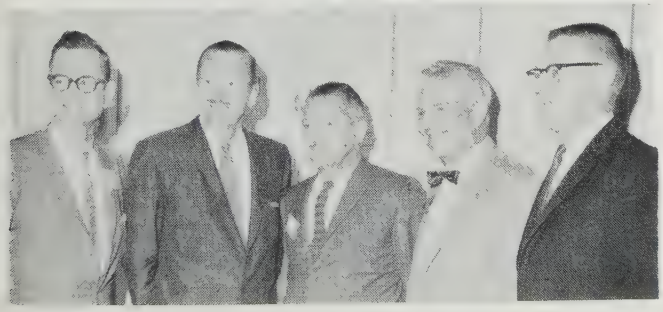
At the Annual Luncheon on Thursday, Sept. 7, 1961, J. M. McEwen, Weyerhaeuser Co., Everett, Wash., reviewed briefly, in a most interesting fashion, the many activities of the various Divisions of TAPPI and emphasized the importance of keeping up with new developments, such as the Corrugated Containers Division was accomplishing, to wit: its present conference. Mr. McEwen, as a member of TAPPI's Executive Committee, extended greetings from Harold M. Annis, president of TAPPI.

An outstanding feature of the luncheon was the presentation of Certificates of Appreciation by Mr. McEwen to A. Richardson, Crown Zellerbach Corp., San Francisco, Calif., retiring chairman of the Engineering Committee and to G. R. Wilmer, American Box Board Co., Grand Rapids, Mich., retiring chairman of the Raw Materials Committee.

Friday, Sept. 8, 1961, was devoted to plant tours and 114 registrants visited the Longview Box Plant in Oakland in the morning, followed by a tour after lunch of the Royal Container Plant at Milbrae.

H. W. Wilson, Royal Container Div., Georgia Pacific Paper Co., San Francisco, Calif., and O. P. Wanamaker, Fiberboard Paper Products Corp., Antioch, Calif., were general conference co-chairmen. Mr. Wanamaker was also responsible for developing the fine technical program. The local arrangements were well done by R. Wright, Philadelphia Quartz Co., Berkeley, Calif. Mrs. R. Wright was hostess of the ladies' program, which was attended by about 30 ladies.

H. T. Scordas, Union Bag-Camp Paper Corp., New York, N. Y., was publicity chairman, and his efforts in developing publicity for the plant tours was a large factor in its success.



Session IV: A. Richardson, Crown Zellerbach Corp., San Francisco, Calif.; P. F. Paul, The Flintkote Co., Los Angeles, Calif.; L. H. R. McGill, St. Regis Paper Co., East Providence, R. I.; R. D. Merrill, Stone Container Corp., Chicago, Ill.; C. Kienzle, Koppers Co., Inc., Monaca, Pa.

WE ARE BASIC PRODUCERS

OF LIQUID SO_2

For Manufacturing

HIGHEST QUALITY
HIGH BRIGHTNESS PULP

We control the purity of our Sulfur Dioxide from the raw Ore to the finished product we deliver to you.

Located in the heart of the Southern Pulp and Paper Industry, we offer you faster service on highest purity Sulfur Dioxide.

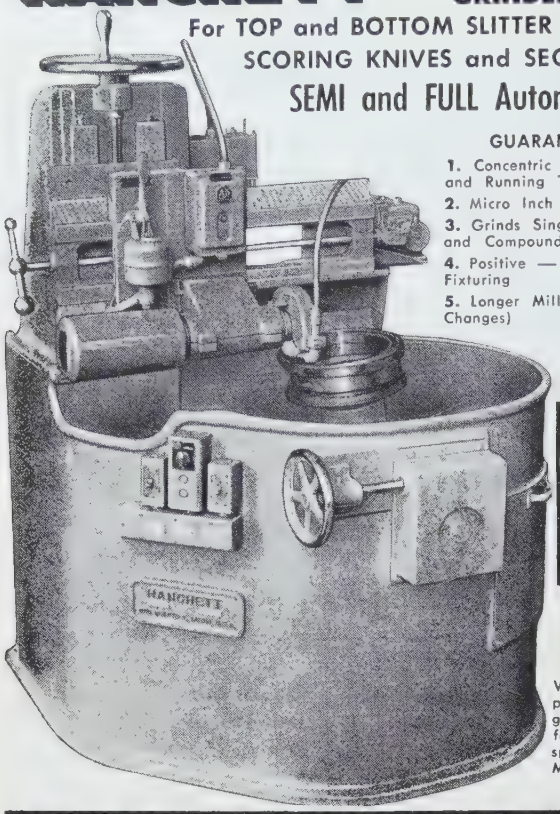
TANK TRUCKS
TANK CARS

CYLINDERS
TON DRUMS

For further information
Phone JAckson 3-5024 or write.

TENNESSEE CORPORATION
612-629 Grant Building, Atlanta 3, Georgia

HANCHETT CIRCULAR KNIFE GRINDER
For TOP and BOTTOM SLITTER KNIVES
SCORING KNIVES and SEGMENTS
SEMI and FULL Automatic



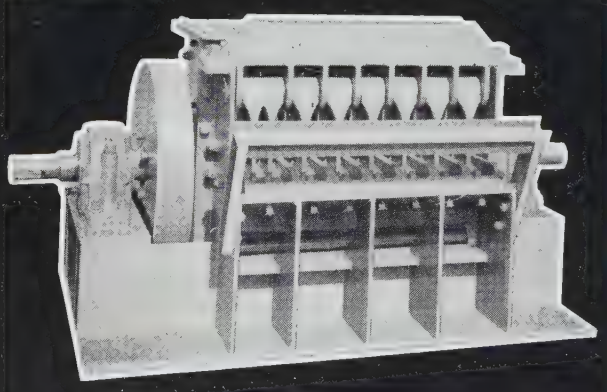
GUARANTEE:
1. Concentric with Bore and Running Truth .0005
2. Micro Inch Finishes
3. Grinds Single, Double and Compound Bevels
4. Positive — Accurate Fixturing
5. Longer Mill Life (Less Changes)

MODEL SK-24 WET GRIND

TEST GRIND
We are prepared to grind knives for your inspection and Mill Test.

HANCHETT MANUFACTURING CO.
Main Office
BIG RAPIDS, MICHIGAN
West Coast
PORTLAND 1, OREGON

Grinds BARK!



JACKSONVILLE BLOW PIPE CO.
P. O. BOX 3687
AREA CODE 305
TELEPHONE EL 5-5671
JACKSONVILLE, FLORIDA

MONTGOMERY KC BLO-HOG

Third TAPPI-ASQC Evolutionary Operation Course

The third course in Evolutionary Operation, jointly sponsored by the Technical Association of the Pulp and Paper Industry, and the Chemical Division, American Society for Quality Control was held at the Schine Inn, Chicopee, Mass., Sept. 15 and 16, 1961.

The third course was organized in response to the widespread interest and oversubscription in the first two courses held in January and March, 1961. Twenty-six students representing Canada, Mexico, and seven states, registered for the course as follows:

John F. Blumenfeld, General Electric Co., 1 Plastics Ave., Pittsfield, Mass.
Dr. H. E. Corwin, Diamond National Corp., Palmer, Mass.
E. J. Hardebeck, Diamond National Corp., Palmer, Mass.
Ronald L. Benson, Fitchburg Paper Co., Fitchburg, Mass.
Leon Germain, Canadian Intl. Paper Co., Montreal, Que.
W. G. Vincent, Strathmore Paper Co., West Springfield, Mass.
A. R. Kendrick, Strathmore Paper Co., West Springfield, Mass.
F. G. Burr, Strathmore Paper Co., West Springfield, Mass.
R. F. Boozer, Westinghouse Elec. Corp., Pittsburgh, Pa.
T. R. Hall, Spaulding Fibre Co., Inc., Tonawanda, N. Y.
Charles R. Culp, Armstrong Cork Co., Lancaster, Pa.
Robert C. Zimmer, Armstrong Cork Co., Lancaster, Pa.
Fran Henriques, Rogers Corp., Rogers, Conn.
R. N. Miller, Buckman Laboratories, Inc., Memphis, Tenn.
S. H. Popovich, Westfield River Paper Co., Russell, Mass.
Ernesto Porras, Celulosa de Chihauhua, S.A., Chihuahua, Chih, Mexico
J. F. Theriault, Continental Can Co., Haverhill, Mass.
J. Robert Koenig, Chas. Bruning Co., Inc., Guilford, Conn.
L. B. Tucker, Crane & Co., Inc., Dalton, Mass.
Edward D. Henze, Kordite Co., Macedon, N. Y.
J. O. Rider, C. K. Williams & Co., Adams, Mass.
Richard L. Roeder, Kimberly Clark Corp., Neenah, Wis.
R. A. Wynes, Clinton Corn Processing Co., Clinton, Iowa
William K. Mohney, American Viscose Corp., Meadville, Pa.
John Terres, Nelco Metals, Inc., Canaan, Conn.
Arthur DerBoghosian, Tileston & Hollingsworth Co., Boston, Mass.

Evolutionary operation (EVOP) is a method of operating a process without interrupting pilot or on-stream production, while simultaneously generating data for improvement of the process. Yields and efficiencies that appear to be possible on the basis of laboratory experiments often produce disappointing results when the process is magnified to on-stream production. Wastage due to low yields or unacceptable quality can be prohibitively expensive. EVOP is one approach to this problem.

The two-day course was given by Dr. J. Stuart Hunter and Truman L. Koehler. Dr. Hunter is a member of the Statistical Staff of the University of Wisconsin and is widely known as a lecturer on Statistical techniques. Mr. Koehler heads the Statistical Analyses Section at the Bound Brook, N. J., plant of American Cyanamid Co. and teaches statistic courses at Rutgers University.

Third TAPPI-ASQC EVOP Course, Chicopee, Mass., Sept. 15–16, 1961

Fourth International Mechanical Pulping Conference

The Fourth International Mechanical Pulping Conference, jointly sponsored by the Technical Association of the Pulp and Paper Industry and the Technical Section, Canadian Pulp and Paper Association, was held Sept. 19–21, 1961, at the Edgewater Beach Hotel, Chicago, Ill. The conference was attended by 316 delegates from 13 countries, and was thus the largest of the four international mechanical pulping conferences held to date. In addition to the United States and Canada, the following countries were represented: Belgium, Chile, England, Finland, Germany, Holland, Ireland, Italy, Mexico, Norway, and Sweden.

The conference program included three days of technical sessions and an official banquet. Of special interest was a full-day symposium on producing mechanical pulp from chips, which included three papers and a panel discussion.

The full text of all papers presented at the conference will appear in a subsequent issue of *Tappi*. In the following account, brief abstracts are given.

Planning Committee

The committee responsible for planning the Mechanical Pulping Conference was as follows:

General Chairman: W. H. de Montmorency, Pulp and Paper Research Institute of Canada, Montreal, Que.

Program Chairman: S. R. Parsons, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis.

Regional Program Chairmen: G. W. Thompson, The Bowaters Research and Development Co., London, England, *Europe;* K. Pingrey, Diamond National Corp., Ogdensburg, N. Y., *Eastern United States;* E. P. Walsh, Anglo-Canadian Pulp and Paper Mills, Quebec, Que., *Eastern Canada;* N. F. Robertson, West Tacoma Newsprint Co., Steilacoom, Wash., *West Coast.*

Publicity: W. H. Copeland, Norton Co. of Canada, Hamilton, Ont.

Sponsoring Committee Chairmen: Tech. Sect., CPPA: H. Richards, Ontario Paper Co., Thorold, Ont. TAPPI: T. F. LaHaise, Ryegate Paper Co., Ryegate, Vt.

Advisory: J. K. Kirkpatrick, Bowaters Southern Paper Corp., Calhoun, Tenn. R. A. Joss, Asst. Executive Secretary, Technical Section, Canadian Pulp and Paper Association. A. J. Winchester, Technical Secretary, Technical Association of the Pulp and Paper Industry.

Opening Session

The conference was officially opened by W. H. deMontmorency, general chairman, on Tuesday morning, September 19, at 9:30 a.m. Mr. de Montmorency welcomed the delegation and briefly reviewed the history of the mechanical pulping conferences held in 1948, 1955, and 1958. He then introduced Lowell Besley, Pulp and Paper Research Institute of Canada, Montreal, Que., who delivered the keynote address of the conference.

Keynote Address

The following is an abstract of Mr. Besley's address:

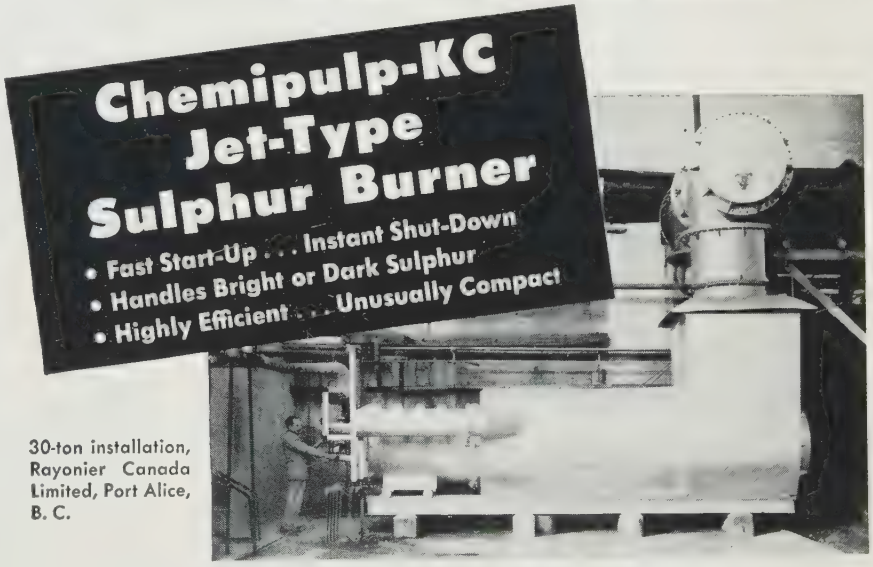
The author explores the possibilities of exerting at least partial control over some wood properties by various logging and forestry measures. Special attention is paid to the freshness of wood, as reflected in its brightness and moisture content, and to the effect of the relative proportions of sapwood and heartwood upon moisture content.

Lowell Besley, Pulp and Paper Research Institute of Canada

Influences of silvicultural methods such as thinning, fertilization, and irrigation and of tree breeding techniques upon wood density, sapwood production, fiber length, ring width, and production of springwood and summerwood are discussed.

It is suggested that the woods operator and the mill superintendent take a close look at the pulpwood together and set up wood specifications with minimum and maximum values of desirable and undesirable properties as well as their optimum averages in the mixture. Some immediate improvement is possible through selection of stands and of trees to log for pulpwood. Longer range forestry measures can provide for more valuable future crops.

The author believes the most pressing need is for the mill to interpret its operating experience and evaluate the resultant product in terms of recognizable characteristics of the wood it uses. Once dollars and cents values can be placed on the various wood properties, they can be compared with the logging and forestry costs of producing pulpwood possessing these properties. On the basis of this information, a mutually beneficial plan can be evolved for supplying the mill with the best mixture of pulpwood economically feasible.


Chemipulp-KC
Jet-Type
Sulphur Burner
• Fast Start-Up . . . Instant Shut-Down
• Handles Bright or Dark Sulphur
• Highly Efficient . . . Unusually Compact

30-ton installation, Rayonier Canada Limited, Port Alice, B. C.

In the Chemipulp-KC Burner, molten sulphur is sprayed into the burner as a fine mist; heated secondary air is then introduced in several stages, resulting in clean, efficient burning. The burner quickly reaches its operating temperature of about 2400°F., minimizing production of SO_3. Operates efficiently at all SO_2 concentrations between 12% and 18½%. At 2100°F, bitumen in dark sulphur is completely burned.

Available in a range of sizes up to 50 tons of sulphur per day and each size will produce SO_2 gas efficiently through a wide operating range. Compact design and flexibility of layout permit installation in limited space.

Write for Bulletin 100

Chemipulp Process Inc. Woolworth Building, Watertown, N.Y.

Associated with Chemipulp Process Ltd., 253 Ontario St., Kingston, Ontario

Pacific Coast: A. H. Lundberg, Inc., P. O. Box 186, Mercer Island, Wash.
Lundberg-Ahlen Equipment Ltd., 779 W. Broadway, Vancouver 10, B. C.

First Session

The first technical session began immediately after the keynote address, under the chairmanship of Mr. deMontmorency. The first paper, "Mechanical Pulping Studies with a Model Steel Wheel," by D. Atack and W. D. May, Pulp and Paper Research Institute of Canada, Montreal, Que., was presented by Mr. Atack.

"Production and Dissipation of Frictional Heat in the Wood Grinding Process," was the title of the second paper by Borje Steenberg and Anders Norstrand, Swedish Forest Products Research Laboratory, Stockholm, Sweden. An abstract of the paper follows:

Using a special technique allowing sampling from the water pulp film between the stone and the log at various points under operation, temperature and consistency conditions in the grinding zone have been determined.

For the experimental 100-hp. grinder used in this work a linear temperature rise under the log has been observed. The maximum temperature does not exceed 100°C.

Based on temperature measurements an average thickness of water-pulp film between wood and stone has been calculated. The apparent film thickness is about 0.1 mm. and decreases with increasing grinding pressure and peripheral speed. It has been calculated that from 15 to 35% of the heat developed in the grinding zone is transported out of it by a heated surface layer of the stone.

This paper reports direct measurements of the temperature distribution over the liquid film between the wood and the grindstone in actual production of mechanical pulp. Pulp samples are also drawn through holes drilled radially to the grinding surface. From the temperature measurements and the consistency measurements information is reached regarding production and dissipation of the frictional heat and the apparent thickness of the film between the log and the stone.

Very little has been published about the energy balance in the process of mechanical groundwood production, and especially the dissipation of frictional heat. It is generally acknowledged that the mechanical energy is within the limits of experimental error converted into frictional heat. A more detailed study requires among other methods for accurate determinations of temperature and other conditions in the actual grinding zone.

Steenberg, *et al.*, have developed a method according to which the liquid film between the wood and the grindstone can be sampled through holes drilled at right angles to the grinding surface. The liquid film was found to be under pressure, which was explained hydrodynamically.

Session I: Chairman W. H. de Montmorency, D. Atack, and W. D. May, Pulp and Paper Research Institute of Canada, Montreal, Que.; B. Steenberg, Swedish Forest Products Research Laboratory, Stockholm, Sweden

Session II: P. M. Quinn, Quebec North Shore Pulp & Paper Co., Ltd., Baie Comeau, Que.; G. E. R. Lamb, State University College of Forestry, Syracuse University, Syracuse, N. Y.; O. Brauns, Central Laboratory of the Swedish Paper Mills, Stockholm, Sweden; F. O. B. Luhde, Anglo Paper Products, Ltd., Quebec, Que.

In this paper experiments are reported where this method has been used to measure the temperature in the boundary film between the log and the grindstone by inserting thermocouples in the holes through which the pulp flows. Further, the consistency of the effluent pulp suspension from the holes has been determined. These figures have been used for an analysis of the dissipation of frictional heat created in the process.

Second Session

P. M. Quinn, Quebec North Shore Paper Co., Baie Comeau, Que., was chairman of the second technical session. Abstracts of the three papers presented during this session are given below:

"Energy Consumption in Mechanical Pulping," by George E. R. Lamb, Empire State Paper Research Institute, Syracuse, N. Y.

Mechanical pulping is compared with the process of peeling adhesive tape. Experiments are described which support the validity of a simple expression which has been derived for the energy of peeling. Values of the energy of surface formation for wood fibers calculated using this expression agree with those obtained experimentally. The agreement holds when the wood is treated with a mild delignifying agent.

"Laboratory Investigations of Relations between Conventional Groundwood Characteristics and Printability," by Otto Brauns and Olle Swanberg, Central Laboratory of the Swedish Paper Mills, Stockholm, Sweden.

One hundred groundwood pulps from 27 mills formed the basic raw material in this investigation. Besides a number of conventional groundwood tests on the pulps and hand-made sheets therefrom, predictive printing quality tests were performed on the sheets which also were printed in an experimental high-speed rotary press. The testing results were subjected to multiple regression analysis with a view to establish relations between printability and groundwood quality. The results showed that optical properties of the sheets were as important as other physical tests on groundwood. The influence of freeness, orill, shives, and Hillbom fractions on the optical properties and printing quality is discussed.

"Survey of Grinder Economics and Operation," by W. Brecht, Institute of Paper Technology, Darmstadt, Germany, and F. Luhue, Anglo Paper Products, Ltd., Quebec City, Canada.

Operating and economic data from a large number of European and North American mills were obtained by means

of questionnaires supported by official technical associations. The results were brought to a common basis and a comparison made between different grinder types.

Generally, European chain grinders are run at higher loads per square foot of grinding area than North American two-pocket grinders. The stock produced for newsprint and similar furnish is freer from the European grinders but the average power used per ton is lower than in North America. The maintenance man-hours reported from Europe were lower as were building costs; however, the capital costs of North American two-pocket grinders were lower. Specific information on many other types of grinders of different ages and in various location is included.

Third Session

The third technical session, on the subject of mechanical pulp from chips, was held on Wednesday morning, September 20, under the chairmanships of G. W. Thompson, The Bowaters Research and Development Co., London, England. Abstracts of the three papers presented are given below:

"The Development and Production of Disk Refiner Groundwood Pulp," by WALTER F. HOLZER, Crown Zellerbach Corp., San Francisco, Calif., JOHN T. HENDERSON, Crown Zellerbach Corp., Camas, Wash., WM. B. WEST, Crown Zellerbach Corp., Camas, Wash., and KENNETH F. BYINGTON, Crown Zellerbach Corp., West Linn, Ore.

The feasibility of producing a printing paper grade of groundwood pulp from chips in disk refiners was demonstrated in the early 1950's in a machinery manufacturer's laboratory. Results were promising enough that Crown Zellerbach began an active program to explore the area of refiner groundwood and develop data which could lead to the commercialization of the refiner groundwood process.

To date, the program which has been followed can be visualized in three phases which include: (1) preliminary work in the manufacturer's laboratory. (2) pilot plant operation in Camas, Wash., at the Central Research Division of Crown Zellerbach, and (3) semi-commercial operation at Crown's West Linn, Ore., mill.

The best pulps produced to date have been produced in a two-stage refining system utilizing high consistency refining and 30 to 50% of the power applied in the first stage. The two-stage, high density refined pulp is generally about 15 to 20% stronger than single stage pulp and also definitely stronger than normal stone groundwood at the same freeness level.

PROXMELT® *announces . . .*

an addition to the family!

Now you can enjoy the benefits of the several types of ETHYLENE-VINYL COPOLYMER RESINS in the "easy-to-use" form.

PROXMELT CONCENTRATES

In these convenient "let downs", you need only stir these sensational new resins into waxes, oils, paraffins, micros, greases, etc.

The rewarding results include: improved versatility, broader adhesion spectrum, better heat stability, and greater strength.

If you are a laminator, mounter, coater or any kind of converter to whom waxy seals, laminants, or films are important, you should investigate this addition to our line of Proxmelt Concentrates.

Details will be quickly sent on receipt of your inquiry to our nearest office.

CHICAGO 32
VI 7-4800

KIMBERTON, PA.
WE 3-8857

Pyroxylin
PRODUCTS, INC.

Mexico, D.F.

Session III: Chairman G. W. Thompson, Bowater Research and Development Co., Ltd., London, England; W. F. Holzer, Crown Zellerbach Corp.; San Francisco, Calif.; W. B. West, Crown Zellerbach Corp., Camas, Wash.; V. B. Bodenheimer, Continental Can Co., Inc., Augusta, Ga.

The effects of refiner groundwood as a complete substitute for stone groundwood in a machine furnish have not been fully evaluated. In some trials, the use of refiner groundwood has led to a stronger sheet. There is some indication that the use of refiner groundwood will improve machine formation and produce a smoother, higher bulk sheet for printing. At present, West Linn has no good facility for extended machine runs. In the future this may be possible, and due to the flexibility of refiners in controlling the characteristics of the fiber produced, it is possible that the groundwood stock can be tailored for demands of a particular furnish.

In conclusion. it has been established to date that the best possible refiner groundwood stock can be produced if the following requisites are allowed for: (1) two-stage disk refining; (2) high-consistency refining; (3) first stage refining power is 30 to 50% of the total; (4) absolute uniformity (positive metering) of feed to the refiner.

The fulfillment of these requisites has led to a superior grade of groundwood pulp. The field of application of disks refiners for groundwood is only starting to be explored and improvements in operation and quality beyond the levels already achieved are to be expected.

"Mechanical Pulp from Chips Laboratory Refining of Softwood and Hardwood Species," by R. M. Dorland, D. A. Holder, R. A. Leask, and J. W. McKinney, Central Research Division, Abitibi Power & Paper Co., Ltd., Sault Ste. Marie, Ont.

Pulps of the groundwood type ("refiner groundwood") have been made from chips in a double-disk refiner. With spruce the strength is high and continues to develop as refining progresses, so that it is superior to stone groundwood at any freeness down to 50 ml. C.S.f.

Pretreatments, such as steaming at atmospheric pressure and a chemical dip, are effective aids for both spruce and softhardwoods, such as aspen; jack pine gives a fair response but on a somewhat lower strength level. The dense hardwoods require a more drastic treatment for good results.

Power requirements are high in all cases, probably equivalent to stone grinding at equal freeness, at any rate for softwoods. The great advantages of the method would be in closer control and flexibility, both for wood species used and products made.

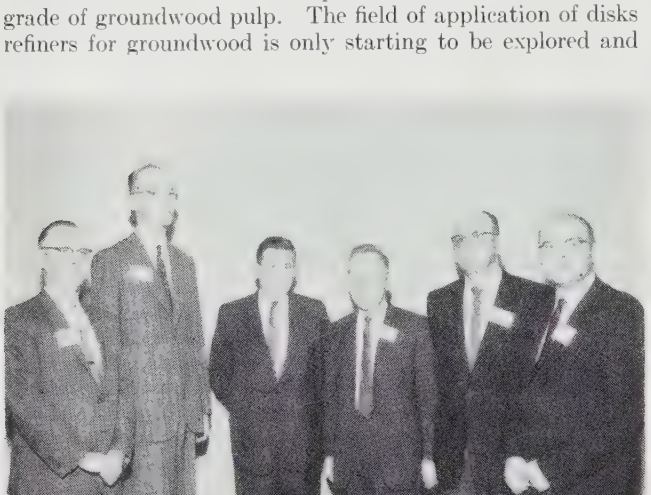
"Cold Caustic Pulp from Single Stage Refining," by John Beaujean and B. V. Bodenheimer, Continental Can Co., Augusta, Ga.

It was decided to build a cold caustic plant along with Continental Can's 350-ton bleached board mill at Augusta in order to achieve higher utilization of mixed hardwoods. The goals set for this plant were ambitious. A high-quality, almost shive-free pulp would be made from mixed hardwoods in a plant costing less than one-tenth of the cost of a comparable bleached kraft pulp mill; horsepower input would not exceed 35 hp. tons per day; freenesses should be a minimum of 350 for good runability on the machine and bleaching and operating costs would be low. Most of these goals have been realized; however, some problems remain.

Fourth Session

The fourth session, held on Wednesday afternoon, September 20, took the form of a panel discussion on Mechanical Pulp from Chips. K. L. Pingrey, Diamond National Corp., Ogdensburg, N. Y., was moderator of the panel, which comprised the following members:

D. L. Stewart, MacMillan, Bloedel and Powell River, Ltd., Nanaimo, B. C.
J. E. Foote, Diamond National Corp., Stamford, Conn.
O. K. J. Sepall, Anglo Paper Products, Ltd., Quebec, Que.
J. N. Swartz, Bowaters Southern Paper Corp., Calhoun, Tenn.
R. L. Johnson, Waldorf Paper Products, St. Paul, Minn.



Session IV: K. L. Pingrey, Diamond National Corp., Ogdensburg, N. Y.; D. L. Stewart, MacMillan Bloedel and Powell River, Ltd., Nanaimo, B. C.; J. E. Foote, Diamond National Corp., Stamford, Conn.; O. K. J. Sepall, Anglo Paper Products, Ltd., Quebec, Que.; J. N. Swartz, Bowaters Southern Paper Corp., Calhoun, Tenn.; R. L. Johnson, Waldorf Paper Products, St. Paul, Minn.

Session V: Chairman T. W. Dobson, Donnacona Paper Co., Ltd., Donnacona, Que.; A. G. Weidhaas, Institute fur Papierfabrikation Technische Hochschule, Darmstadt, Germany; J. K. Kirkpatrick, Bowaters Southern Paper Corp., Calhoun, Tenn.

Session V: J. K. Kirkpatrick, Bowaters Southern Paper Corp., Calhoun, Tenn.; C. Anker, Risor Tremassefabriker, Risor, Norway; J. W. Griffin, Great Northern Paper Co., Millinocket, Me.; R. Murley, Bowaters Newfoundland Pulp and Paper Co., Ltd., Corner Brook, Nfld.; H. P. Richards, The Ontario Paper Co., Ltd., Thorold, Ont.; G. W. Thompson, The Bowater Research and Development Co., Ltd., London, England; R. W. Hawkes, Montague Machine Co., Turners Falls, Mass.

A transcript of the discussion will be available from the Technical Section, CPPA, 2200 Sun Life Building, Montreal, Que.

Fifth Session

T. W. Dobson, Donnacona Paper Co., Donnacona, Que., was chairman of the fifth technical session held on Thursday morning, September 21. "Relations of Groundwood Screening Procedures," was the title of the one paper presented during this session. The paper was prepared by W. H. Brecht and A. G. Weidhaus, Institute für Papierfabrikation, Technische Hochschule, Darnstadt, Germany, and was presented by Mr. Weidhaus, whose present address is Weyerhaeuser Timber Co., Longview, Wash. An abstract of the paper follows:

The screens of newly installed screening equipment in a pilot groundwood plant were tested experimentally. These tests with two rotary screens—operated as centrifugal screens as well as outward flow screens—and with a knotter screen provided a basic comparison of performance of their screening effects. Furthermore the fundamental relations of the screening process were stated, whereby the relative stock weight retention at a screen proved to be one of the most important screening coefficients, while the fiber index turned out to be an important figure for the evaluation of the screen-ability of a groundwood pulp.

Panel Discussion. The remainder of the Thursday morning session was devoted to a panel discussion on "Grinder Operations Breakthrough." J. K. Kirkpatrick, Bowaters Southern Paper Corp., Calhoun, Tex., was moderator of the following panel:

C. Anker, Risor Tremassefabriker, Risor, Norway
W. Griffin, Great Northern Paper Co., Millinocket, Me.
R. Murley, Bowaters Newfoundland Pulp and Paper Co., Ltd., Corner Brook, Nfld.
H. P. Richards, The Ontario Paper Co., Ltd., Thorold, Ont.
G. W. Thompson, The Bowater Research and Development Co., Ltd., London, England
J. H. Perry, Norton Co., Worcester, Mass.
R. W. Hawkes, Montague Machine Co., Turners Falls, Mass.

Sixth Session

The last session of the conference, on Thursday afternoon, September 21, was chaired by T. G. LaHaise, Ryegate Paper Co., Ryegate Vt.

Piero Bersano, Cartiere Burgo, Torino, Italy, presented a paper and movie film on the Bersano grinding Process.

Session VI: Chairman T. F. Lahaise, Jr., Ryegate Paper Co., Ryegate, Vt.; P. Bersano, Cartiere Burgo, Torino, Italy; A. D. Armstrong, St. Regis Paper Co., Deferiet, N. Y.; E. P. Walsh, Anglo Canadian Pulp & Paper Mills, Ltd., Quebec, Que.

"Continuous High Density Bleaching of Groundwood," was the title of the second paper by A. D. Armstrong, D. M. Ferguson, and R. P. Hamilton, St. Regis Paper Co., Deferiet, N. Y., R. J. Rosebush, Food Machinery and Chemical Corp., Princeton, N. J., and P. O. Jordan, Food Machinery and Chemical Corp., San Jose, Calif. An abstract of the paper follows:

Pilot plant work, results of the installation, start-up and commercial operation of a high-density (25% o.d.) groundwood bleach plant are discussed. Pilot plant work indicated that 1 and 2% hydrogen peroxide (50% solution) on o.d. pulp would produce 70 and 75 brightness, respectively, under high density conditions. This was substantiated on a commercial scale. Peroxide requirements to obtain brightness levels of 79 to 80 in a single stage appear to be practical.

The design and operation of screw presses to dewater 12% groundwood to 30% o.d. density proved successful. No high density knots were present in the pulp delivered to the paper mill.

The efficiency of the commercial installations suffered from the effect of extraneous metal ions. This was considered to

Session VI: E. P. Walsh, Anglo Canadian Pulp & Paper Mills, Ltd., Quebec, Que.; L. Gagnon, John Breakey, Ltd., Breakeyville, Que.; H. M. Hughson, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.; C. R. Powell, The E. B. Eddy Co., Hull, Que.; S. Shinkle, Publishers Paper Co., Oregon City, Ore.; J. M. Cairnie, The Ontario Paper Co., Ltd., Thorold, Ont.

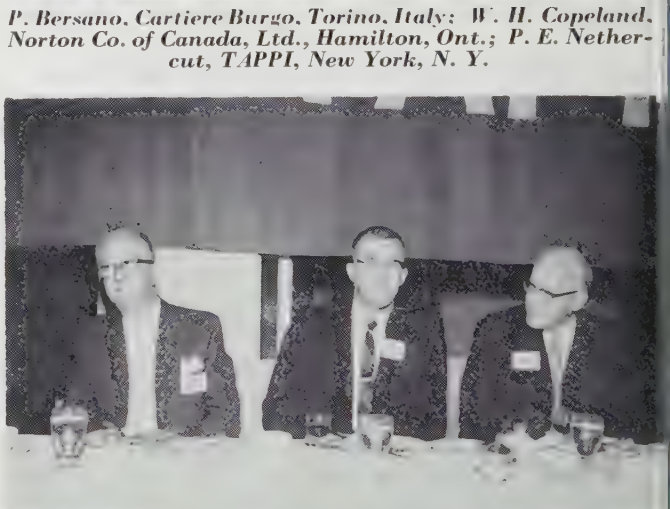
H. O. Teeple, TAPPI, New York, N. Y.; K. L. Pingrey, Diamond National Corp., Ogdensburg, N. Y.; T. McCarthy, Clowdalkin Paper Mills, Co., Dublin, Ireland; G. F. Underhay, The Bowater Paper Co., Inc., New York, N. Y.

G. F. Underhay, The Bowater Paper Co., Inc., New York, N. Y.; J. K. Kirkpatrick, Bowater Southern Paper Corp., Calhoun, Tenn.; A. J. Winchester, TAPPI, New York, N. Y.; G. Thompson, Bowater Paper Corp., Ltd., London, England

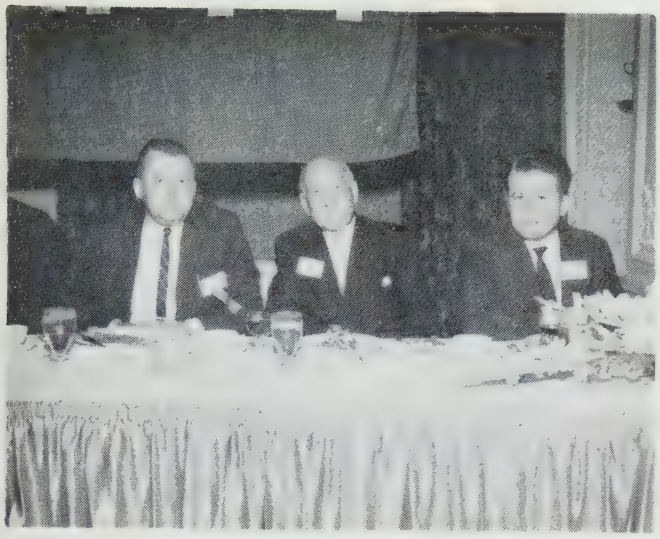
A. L. Mahler, Van Gelder Zonen, N. V., Amsterdam, Holland; H. P. Richards, Ontario Paper Co., Thorold, Ont., P. Bersano, Cartiere Burgo, Torino, Italy

P. Bersano, Cartiere Burgo, Torino, Italy; W. H. Copeland, Norton Co. of Canada, Ltd., Hamilton, Ont.; P. E. Nethercut, TAPPI, New York, N. Y.

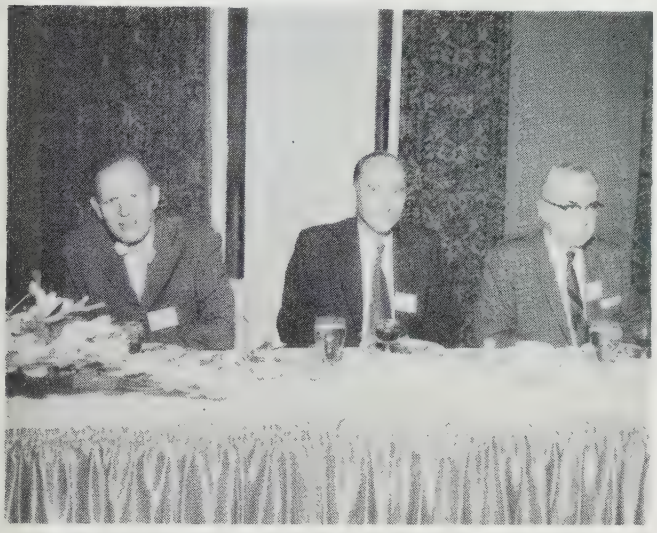
E. L. Neal, Gaspesia Pulp & Paper Co., Chandler, Que.; R. K. Burns, University of Chicago, Chicago, Ill.; W. H. de Montmorency, Pulp & Paper Research Institute of Canada, Montreal, Que.; J. C. Wollwage, Kimberly-Clark Corp., Neenah, Wis.



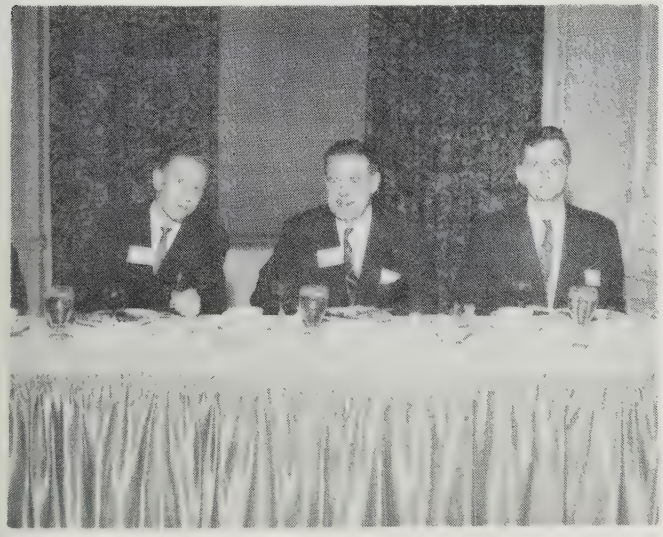
D. Jones, Canadian Pulp & Paper Association, Montreal, Que.; S. R. Parsons, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.; C. Anker, Risor Tremasseabriken, Rioser, Norway



T. F. Lahaise, Jr., Ryegate Paper Co., East Ryegate, Vt.; F. Schwartz, Voitwork Machineplant, Heidenheim/Brenz, West Germany; E. P. Walsh, Anglo Canadian Pulp & Paper Mills, Ltd., Quebec, Que.



B. Steenberg, Swedish Forest Products Research Laboratory, Stockholm, Sweden; W. M. Lake, South African Pulp & Paper, Ind., Ltd., Enstra, South Africa; N. F. Robertson, West Tacoma Newsprint Co., Steilacoom, Wash.



J. H. Hefter, Cia. Manufacturera Papeles y Cartones, Santiago, Chile; B. T. Nyman, A. Ahlstrom Osakeyhtid, Karhula, Finland; H. Joss, Canadian Pulp and Paper Association, Montreal, Que.

be a local problem. Methods of combating the effects of metal ions with complexing agents are discussed.

Panel Discussion. The remainder of the Thursday afternoon session was devoted to a panel discussion on "Layout of an Ideal Groundwood Mill." E. P. Walsh, Anglo Canadian Pulp & Paper Mills, Quebec, Que., was moderator of the panel, which consisted of the following members:

L. Gagnon, John Breakey Ltd., Breakeyville, Que.
H. M. Hughson, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
C. R. Powell, The E. B. Eddy Co., Hull, Que.
S. Shinkle, Publishers Paper Co., Oregon City, Ore.
R. T. Wetmore, The Ontario Paper Co. Ltd., Thorold, Ont.

Official Banquet

The official banquet of the conference was held on Wednesday evening, September 20, and was presided over by W. H. de Montmorency, general chairman, who introduced the head-table guests and called upon Robert K. Burns, associate dean of the Graduate School of Business Administration and Executive Director of the Industrial Relations Center, University of Chicago. Professor Burns spoke on "Management and the Development of Leadership Skills."

Fifth Mechanical Pulping Conference

The Fifth International Mechanical Pulping Conference will be held in 1964 on the Canadian West Coast. Suggestions concerning the conference and offers of papers should be addressed either to The Technical Section, CPPA, 2280 Sun Life Bldg., Montreal, Que., or to TAPPI, 360 Lexington Ave., New York 17, N. Y.

Fourth

International

Technical Pulping

Conference

Reprints

of

Conference Papers

$3.00 per copy

(while they last)

Write to the

Technical Association

of the

Pulp and Paper Industry

360 Lexington Ave.,

New York 17, N. Y.

for your copy

TAPPI NOTES

Reference Materials for Testing

The Association's role in the development of test methods is widely recognized and appreciated. TAPPI Standard Testing Procedures have won broad acceptance both in this country and overseas. TAPPI Routine Control Methods represent another valued contribution to the industry's technology, as does the distribution of the TAPPI Reference Pulp for use in the calibration of laboratory beaters.

Since 1958 the Association has participated in another type of testing program in line with its stated object of "providing technical facts, data and standards, fundamental to pulp and paper manufacture and use." This is a joint undertaking with the American Paper and Pulp Association and the National Bureau of Standards for the development of reference materials for paper testing. The first of these reference materials, slated for distribution early in 1962, is designed to reduce the variability of Elmendorf tearing strength tests. Detailed announcements of this new service will be published shortly. Before then, however, it is quite appropriate to review the events leading to the development of this tearing strength reference material.

In 1957, at the request of the APPA Instrumentation Research Committee, The Institute of Paper Chemistry conducted a round robin testing program to determine the variability existing among testing instruments currently used by the industry. The test results for approximately 300 instruments used for the evaluation of bursting strength, tearing strength, and brightness were compared using standard test specimens. The data disclosed a surprisingly large variability among test instruments which were not under a regular standardization and calibration service. It was concluded that an industry-wide service of this type should result in a significant reduction in the variability of the test data. Obviously, the establishment of such a service would be a sizable and complex undertaking requiring extensive personnel and shop facilities.

Since APPA and TAPPI have a common interest in testing instruments and procedures, a joint committee of the two associations was formed in 1958 to consider means of reducing test data variability through the use of reference test samples. The Paper Section of the National Bureau of Standards was asked to assist in the preparation and distribution of such reference materials. As the initial step in this program the Bureau was requested to develop a reference paper sample for the Elmendorf tearing test. This test was selected because the instrument is relatively simple, the test is widely used by the industry, and the variability in the test had been demonstrated in the 1957 round robin testing program undertaken by The Institute of Paper Chemistry.

With the guidance of the APPA-TAPPI Reference Materials Committee the Bureau conducted two additional round robin studies of the tear test. Roughly 40 industry laboratories participated in these tests. The results of the tests indicated that the use of a reference material would permit significant improvements in agreement on tearing strength values between and within laboratories. The tests also demonstrated the need for proper conditioning of the samples and for certain refinements in the testing procedure.

The Bureau has worked closely with The Institute of Paper Chemistry in the design of these experiments, the analysis of data, and the preparation of reference material samples. The Bureau is undertaking to provide these reference specimens to the paper industry on a modest subscription basis, and the details of this service will be announced shortly. If this service for the tearing test is of value to the industry, it will be extended stepwise to other test instruments in the future.

The work of the Reference Materials Committee is an outstanding example of effective cooperation between individual companies, industry associations, research institutes, and the government. Under the capable chairmanship of M. L. Taylor, Union Bag-Camp Co., this committee has brought a variety of talents and viewpoints to bear on a technical problem of utmost concern to the paper industry. The contributions of T. S. Lashof of the National Bureau of Standards and W. Wink of The Institute of Paper Chemistry to this program are particularly noteworthy.

The use of reference materials for reducing tearing test variability should provide both commercial and scientific benefits to the paper industry. Moreover, the pioneering techniques developed and improved in this program may well lead to equally valuable applications in other areas of paper testing.

P. E. Nethercut

TAPPI PROFILE

Gunnar W. E. Nicholson

GUNNAR W. E. NICHOLSON, president and director of the Tennessee River Pulp and Paper Co., New York, N. Y., has been associated with the pulp and paper industry in Sweden, Canada, and the United States for 45 years. With the completion of the new mill at Counce, Tenn., he has added one more star to a very satisfying career. Over the years following his graduation from the Chalmers Institute of Technology he spanned the wide field of practical and technical experience in many branches of the industry.

His background of work in small and large mills developed in him that quality that made him a leader, especially among men in the industry. He is an indefatigable worker and expects his assistants and associates to maintain the same pace as he. As a result many of the men he led attained higher positions in the industry than they might have had they been allowed a more leisurely development.

His vision has been outstanding. Knowing from experience what was needed to maintain a company as a success, he focused his attention on Men, Materials and Money. He indicated pride in the people with whom he surrounded himself; they were well qualified when he called them and he provided opportunities for their growth. The materials of pulp making—especially trees, woodlands, and forest biology absorbed much of his attention. His interest made him associate as much with the professors in schools of forestry as with his own company foresters. The third *M*, Money, has been reflected by his demand for the best in paper manufacturing equipment, efficient engineering practices and an alert appraisal of all that is new in industrial technology. For such a man, his latest fine accomplishment at Counce would appear to have all the facets of the very best to date.

Born in Sweden in 1893, he graduated in chemical engineering from the Chalmers Institute of Technology, Gothenburg. From 1916 to 1921 he held various jobs in paper mills in Sweden. He was assistant superintendent at Klippans, Finpappersbruk, Klippan; superintendent at A/B Brusafore-Hallefors paper mill and at Tegeforsverk, Japen.

In 1921 he came to the United States, planning to spend only two years studying pulp and papermaking. He returned to Sweden 25 years later, for a visit. In that year, 1946, Mr. Nicholson was a member of a study group of industry representatives sent by the United States Government to the Scandinavian countries for the purpose of extending goodwill and exchanging information. This group comprised the foremost leaders in research, industry, and education in this country.

His first job here was that of assistant superintendent of Poland Paper Co., Mechanic Falls, Me. From there he went to the Superior Paper Co., Franklin, Ohio, as superintendent. In 1923, he went to Canada and joined Western Quebec Paper Mills, Ltd., at St. Andrews East, Que., as superintendent. Other companies for which he worked in Canada were the Riordon Pulp and Paper Company (now part of International Paper Co.), Temiskaming, Que., the Canada Paper Co., and Howard Smith Paper Mills, Ltd., Cornwall, Ont. In 1927 he returned to the United States to become general superintendent of the Bogalusa Paper Co. (now part of the Crown Zellerbach Corp.), Bogalusa, La. During the years 1931 and 1941 he was superintendent and manager of the Mobile, Panama City, and Georgetown Mills of the Southern Kraft Div., International Paper Co. From 1941 to 1945 he was resident manager of the Savannah, Ga., mill of the Union Bag-Camp Paper Corp. In 1945 he became vice-president, and in 1952 executive vice-president of the company.

Since 1956 he has been president and director of Tennessee River Pulp and Paper Co. The new $40 million kraft linerboard plant at Counce was built under his direction. Incorporating the latest methods of automation in the paper industry, all pulping operations in the plant, from chip bins to high density storage tanks, are remote controlled from a central control room (see *Pulp and Paper* 33, No. 13: 3 (June 26, 1961)).

He is also a director of the Standard Packaging Corp., New York, the Fourdrinier Kraft Board Institute, Inc.; and of the American Forest Products Industries Association; a member of the operating committee and director of the National Council for Stream Improvement; and a trustee of Norwich University, Norwich, Vt.

Mr. Nicholson became a member of TAPPI in 1925, and president of the Association in 1946. He was very active in the formation of the Alkaline Pulping Division, and was largely responsible for reorganizing the Engineering Division and initiating its annual conferences. He also encouraged the establishment of the Corrugated Container Division and the Corrosion Committee.

He was instrumental in forming the Southeastern Section of TAPPI, and has been one of the leaders in most of the important projects which have been undertaken throughout the South and East. He helped work out a pension plan for the TAPPI headquarters staff, and is now chairman of the TAPPI Investment Advisory Committee. In 1954 he was awarded the Association's highest award, the TAPPI Gold Medal.

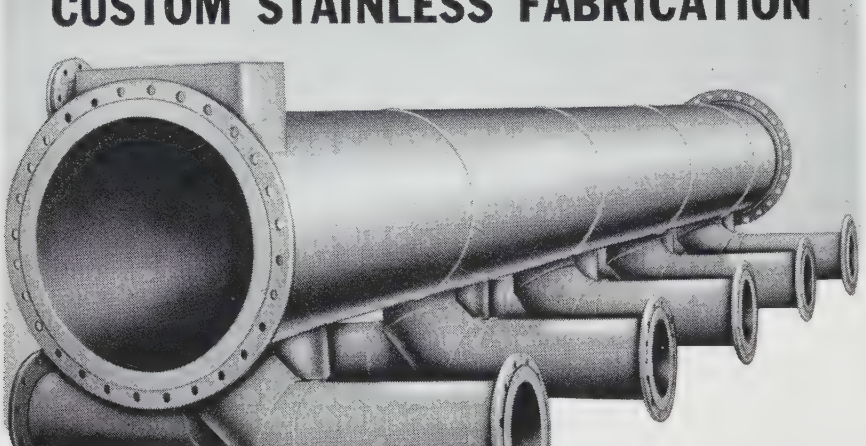
The TAPPI Medal is only one of the many honors that have been bestowed upon him: In 1946 he received the Congressional Service Medal for war service, and in that year also he was voted an honorary membership by the Swedish Association of Pulp and Paper Engineers for his outstanding contributions to international pulp and paperboard technology—an honor that had been bestowed at the time to only three other persons. He is also an honorary member of the Swedish Academy of Engineering Science—an honor usually bestowed on winners of the Nobel Prize. In 1960 he was elevated from the rank of Knight to that of Commander of the Royal Order of Vasa by his Majesty King Gustav of Sweden. In 1950 he was among those selected by the United States Government to help rehabilitate the Austrian paper industry through the Marshall Plan. Unfortunately, he was unable to accept this assignment.

Like many leaders in the paper industry, Mr. Nicholson attaches great importance to furthering the education of paper industry personnel and their dependents. He would like to see more companies offering scholarships and fellowships to employees and their children, recognizing talents, and encouraging ambitions. In general, he feels that the paper industry is slow to apply the latest developments to the technology of pulp and papermaking. Increasing the level of education of paper industry personnel would help reduce this time lag and allow a more rapid adjustment of the industry to the scientific age in which it is operating. Recognizing that such progress thrives on the free exchange of technical information, Mr. Nicholson is highly in favor of the well-organized technical conference as a forum for the exchange of ideas. However, and here he offers cautious advice, such conferences can realize their maximum usefulness only if they are run on a "strictly business" basis. To emphasize their importance, he requires his employees to submit a written report on the proceedings of all conferences they attend. These reports then become part of an employee's record of progress.

Among the many societies and clubs to which he belongs are the following: Newcomen Society, Engineering Institute of Canada, Technical Section of the Canadian Pulp and Paper Association, American Forestry Association, National Council of Boy Scouts of America, Society of American Foresters, Conservation Committee of National Association of Manufacturers, American Management Association, National Industrial Conference Board, University Club of New York, Canadian Club of New York and Church Club of New York.

Mr. and Mrs. Nicholson, the former Lillian Greenough of Montreal, live in Manhattan where he walks 24 blocks to and from work every day. He enjoys music, the theater, and travel.

CUSTOM STAINLESS FABRICATION



Selectifier Screen Header
Built for
Great Northern Paper Company
East Millinocket, Maine

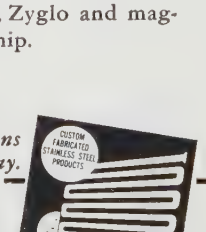
High Quality
Fast Service
Low Production Costs

For fast service, one of the largest stocks of stainless in New England is maintained. Over a quarter million dollar inventory and over 400,000 lbs. are readily at hand for prompt fabrication service.

More than 30 years experience in stainless fabrication is your assurance of the right grade for the application and the most dependable source of supply. Strict quality control program includes X-Ray, Zyglo and magnetic particle inspection to assure top grade workmanship.

Let us quote on your very next job.

Free brochure illustrates applications and facilities. Mail coupon today.



Portland
COPPER & TANK WORKS, INC.
80 Second Street, South Portland, Maine
SPruce 9-3341 TWX PO 270

Please send your brochure which illustrates stainless applications and your facilities.

Name _____
Company _____
Address _____
City _____ State _____

PERSONAL MENTION

New TAPPI Members

Thomas Agnew, Jr., Sulphite Superintendent, Alliance Paper Mills, Ltd., Merritton, Ont.

Ludwig F. Akkeron, Chemist, The Meyerecord Co., Chicago, Ill., a 1954 graduate of Roosevelt University.

Roy E. Baharian, Project Manager, M. W. Kellogg Co., New York City, N. Y., a 1944 graduate of Worcester Polytechnic Institute.

Sheldon Brooks, Alpha Chemist, Alaska Lumber and Pulp Co., Inc., Sitka, Alaska, a 1958 graduate of Pacific Lutheran University.

N. E. Burgess, Manager-Owner, Southern Chemical Associates, New York City, N. Y.

Giorgio Calanca, Chief Engineer, Arnoldo Mondadori Editore, Milan, Italy, a 1950 graduate of Polytechnical University of Milan with a Ph.D. degree.

James E. Carbino, Quality Control Supervisor, Case Bros., Brattleboro, Vt.

Gunnar O. W. Collin, Chemical Engineer, Kamyr AB, Karlstad, Sweden, a 1950 graduate of Royal Institute of Technology, Stockholm.

Robert Conway, Jr., Manager, Pulp & Paper Mill Sales, Walworth Co., New York, N. Y., a 1948 graduate of Louisiana State University.

Donald C. Cullingham, Project Engineer, Parsons & Whittemore, Paris, France, a 1950 graduate of University of Toronto.

Dean C. Douglas, Assistant Manager, Administration Engineering Research Div., Scott Paper Co., Philadelphia, Pa., a 1955 graduate of Drexel Institute of Technology.

Garland T. Edmonds, Assistant Paper Mill Superintendent, The Chesapeake Corp. of Virginia, West Point, Va., a 1951 graduate of Virginia Polytechnic Institute.

Eric G. Ehrnrooth, Project Engineer, Jaakko Poyry Consulting Engineers, Helsinki, Finland, a 1951 graduate of Abo Akademi.

Tage Engstrom, Local Manager, Lessebo AB, Lessebo, Sweden. Attended Technical Institute in Norrkoping.

Joseph Felshin, Publisher, New Century Publishers, Inc., New York, N. Y., a 1924 graduate of Columbia University.

Egidio Fusari, Technical Director, FICIS Fabbrica Italiana di Colori ed Inchiostri da Stampa, Milan, Italy.

Rafael Chapa Galindez, General Manager, "La Papelera Espanola" S.A., Madrid, Spain.

W. Thomas Gauld, Project Engineer, E. D. Jones Corp., Pittsfield, Mass., a 1951 graduate of Harvard University.

John J. Gralenski, Bacteriologist, R. T. Vanderbilt Co., Inc., East Norwalk, Conn., a 1957 graduate of the University of Massachusetts.

Piero Grassi, Consultant, FICIS Fabbrica Italiana di Colori ed Inchiostri da Stampa, Milan, Italy.

Kurt Herrmann, Technical Director, Perutz Photowerke GmbH, Munich, Germany, a 1936 graduate of University of Berlin.

Ronald C. Jacobs, Technical Representative, Schenectady Varnish Co., Schenectady, N. Y., a 1953 graduate of Union College.

Gordon C. Johnson, Development Engineer, Silicones Div., Union Carbide Corp., Tonawanda, N. Y., a 1952 graduate of City College of New York.

Lars B. Jordansson, Chief Engineer, AB Karlstads Mek Werkstad, Karlstad, Sweden, a 1954 graduate of Chalmers Technical University.

Susumu Kawai, Engineer, Taiko Pulp & Paper Mfg. Co., Ltd., Shizuoka-Ken, Japan, a 1951 graduate of Shizuoka University.

Satram L. Keswani, Cellulose Chemist, Ing. A. Maurer S.A., Berne, Switzerland, a 1951 graduate of College of Science, Banares University, with a Ph.D. degree in 1960.

Shogo Kobayashi, Engineering Dept., Kobayashi Engineering Works, Ltd., Shizuoka-Ken, Japan, a 1956 graduate of Nihon University.

Laurice W. McCallum, Technical Representative, J. M. Huber Corp., New York, N. Y., a 1942 graduate of Texas Technological College.

James A. Murphy, Assistant to the President, International Paper Co., New York, N. Y., a 1937 graduate of Swarthmore College.

Hans Nachtsheim, Control Chemist, Howard Smith Paper Mills, Ltd., Cornwall, Ont., Canada.

Hiroshi Nakagawa, Chief of Mfg. Sect., Tokai-Electro-Chemical Co., Ltd., Shizuokaken, Japan, a 1945 graduate of Tokyo Imperial University.

Philip S. Nathan, Technical Service Representative, General Tire & Rubber Co., Akron, Ohio, a 1956 graduate of University of Illinois.

Viljo Edvard Nurminen, Technical Director, Osuuskunta METEX Andelslag, Helsinki, Finland, a 1940 graduate of Institute of Technology.

M. Peleato, Consultant, La Montananesa, S.A., Zaragoza, Spain, a 1934 graduate of Universidad Zaragoza.

Edward J. Peterson, Quality Control Supervisor, Connelly Container, Inc., Philadelphia, Pa., attended Villanova University.

E. G. Pope, Manager, United Empire Box Co. (Containers), Ltd., Frankton, N. Z.

Donald O. Prielipp, Forest Pathologist, Kimberly Clark Corp., Norway, Mich., a 1951 graduate of University of Minnesota.

Kenneth R. Schuman, Technician, Paper Laboratory, A. E. Staley Manufacturing Co., Decatur, Ill.

Charles Shapiro, Technical Director, Hopper Paper Co., Taylorville, Ill., a 1951 graduate of New York University.

Emil Smerechniak, Chemist, United Paste & Glue Corp., New York, N. Y., a 1948 graduate of Fordham University.

T. Richard Snedden, Sales Development—Technologist, Shell Chemical Co., New York, N. Y., a 1951 graduate of Carnegie Institute of Technology.

Harriet H. Tellefsen, Librarian, J. P. Stevens & Co., Inc., Garfield, N. J.

Lucien F. J. Wielemans, Plant Manager, Papeteries De Ruysscher S.A., Maresquel, France.

Gordon R. Williams, Director, Midwest Inter-Library Center, Chicago, Ill., a 1936 graduate of Stanford University.

Tadashi Yamamoto, Chief of Packaging Research Div., Research Institute of Industry of Hyogo-Prefecture, Kobe, Japan, a 1938 graduate of Osaka University.

John Young, General Manager, Olin-Mathieson Chemical Co., Joliet, Ill., attended Queens University.

Michael Zaleski, Research Engineer, Ontario Paper Co., Ltd., Thorold, Ont., Canada, a 1951 graduate of St. Andrews University.

Appointments

George R. Adams, formerly student at the New York State College of Forestry, is now a research chemist with Armstrong Cork Co., Lancaster, Pa.

Joseph J. Aid is now Director of Research for Boxboard and Folding Cartons of Continental Can Co., Chicago, Ill.

James D. Allen, formerly of Bergstrom Paper Co., is now in the Pulp and Paper Technical Services Department of FMC Corp., Princeton, N. J.

Richard G. Allen of Packaging Corp. of America has been transferred from Quincy, Ill., to Tama, Iowa, as mill chemist.

Pekka V. Altonen, Pulp Mill Superintendent, formerly with Lohja-Kotka Oy, is now with Joutseno-Pulp Oy, Joutseno, Finland.

Michael J. Andrassy, formerly of Lutcher S/A, is now an engineer with E. & B. Cowan, consulting engineers, Montreal, Que.

Roy S. Arrandale, Vice-President in Charge of Engineering for Thatcher Glass Mfg. Co., has transferred his office from New York City to Elmira, N. Y.

Lewis R. Ayers of Continental Can Co. has been transferred from Elkhart, Ind., to Chicago, Ill., as Manager of Folding Carton Research.

Maurice E. Blew is now Quality Control Manager of Strathmore Paper Co., West Springfield, Mass.

Lars Bovin, formerly of Westerviks Papersbruks A/B, is now Mill Manager of Fridafors Fabriks A/B, Fridafors, Sweden.

James J. R. Cheng, formerly of National Cash Register Co., is now Manager of the Research Laboratory of Allied Paper Corp., Kalamazoo, Mich.

Stephen R. Collins, formerly student at the University of Maine, is now a chemist for Kimberly-Clark Corp., New Milford, Conn.

Richard A. Dando, Technical Service Engineer for the St. Regis Paper Co., has been transferred from Carthage, N. Y., to the Technical Center at West Nyack, N. Y.

Clyde Davis, formerly of Finch, Pruyn & Co., is now in sales service for Great Northern Paper Co., New York, N. Y.

Joaquin de la Roza, formerly of Beloit Iron Works, is now Vice-President of de la Roza Corp., New York, N. Y.

Isaac R. Dunlap, formerly of the Brown Co., is now a chemist for the Permacel Division of Johnson & Johnson, New Brunswich, N. J.

William M. Ebersole, formerly of Georgia Kraft Co., is now Manager of Production of Rome Kraft Co., Rome, Ga.

Joseph J. Fiori, formerly of Hinde & Dauch Paper Co. of Canada, is now Assistant to the President of Columbia Box Board Mills, Inc., Chatham, N. Y.

Fred H. Freuler is now Director of Papermaking and Mechanical Development for the West Virginia Pulp & Paper Co., Covington, Va.

Girard L. Calehuff is now Director of Research for West Virginia Pulp & Paper Co., Covington, Va.

Isaiah Gellman, formerly of the National Council for Stream Improvement, is now in the Department of Sanitary Engineering, Johns Hopkins University, Baltimore, Md.

Alex Glassman, formerly of R. R. Donnelly & Sons Co., is now Director of Purchases for the I. S. Berlin Press, Chicago, Ill.

Percival P. Gooding has retired as Technical Director of Strathmore Paper Co., West Springfield, Mass.

C. M. Green is now President and General Manager of Mosinee Paper Mills Co., Mosinee, Wis.

Robert W. Grott, formerly of J. O. Ross Engineering Division, is now Director of Engineering for the AER Corp., Ramsey, N. J.

William D. Hall, formerly of the Folding Paper Box Association, is now a graphic arts and packaging consultant in Elmhurst, Ill.

Lars A. Hartman, formerly with Forano, Ltd., is now Director of the Institute for Development of Forestry and Forest Industries (FAO), Santiago, Chile.

Thomas J. Henry is now Northeast District Sales Manager for John W. Bolton and Sons, Inc., Lawrence, Mass.

Robert W. Hohman is now Midwest District Sales Manager for John W. Bolton and Sons, Inc., Lawrence, Mass.

John H. Hron, formerly of American Marietta Co., is now Technical Representative for Schenectady Varnish Co., Inc., Schenectady, N. Y.

Joseph J. Kilian is now Papermaking Process Development Research Director for the West Virginia Pulp & Paper Co., Covington, Va.

William O. Kroeschell, formerly of Michigan Carton Co., is now Technical Director of Waldorf Paper Products Co., St. Paul, Minn.

Elton Krogel is now Pulp Mill Superintendent for Rhinelander Paper Co., Rhinelander, Wis.

Frank B. Loppnow of Kimberly-Clark Corp. has been transferred from Neenah, Wis., to Niagara Falls, N. Y., as Production Superintendent.

Daniel E. Lucas of Corn Products Sales Co. has been transferred from Argo, Ill., to New York, N. Y., as Eastern Regional Sales Service Manager.

Donald J. Maclaurin, formerly with Island Paper Mills, is now in the Chemistry Department of Victoria College, Victoria, B. C.

Myron P. Marander, formerly of Fibreboard Paper Products, Inc., is now with the Weyerhaeuser Co., Longview, Wash.

Robert H. Marchessault, formerly of American Viscose Co., is now an Associate Professor at the New York State College of Forestry, Syracuse, N. Y.

Tapani Marttala, formerly of Lohja-Kotka Oy, is now a Project Engineer for Metex Cooperative Corp., Helsinki, Finland.

Robert J. Menard, formerly of Nalco Chemical Co., is now a utilities engineer for Scott Paper Co., Mobile, Ala.

Ronald G. Morgan is now Assistant Superintendent the Angell St. Mill of Michigan Carton Co., Battle Creek, Mich.

William R. Morrison, formerly of A. M. Collins Division, is now a salesman for International Paper Co., New York, N. Y.

Jerrold H. Moyer, formerly of Champion Papers, Inc., is now Technical Director of Gilman Paper Co., Gilman, Vt.

John P. Munton of Rice Barton Corp. has been transferred from Worcester, Mass., to Portland, Ore., as Manager of Western Sales.

William H. E. Neuss, formerly of Armour Alliance Industries, is now in the Sales Development Laboratory of the Borden Chemical Co., Bainbridge, N. Y.

Douglas P. Newcomb, formerly of the Orton Corp., is now a sales engineer for Manchester Machine Co., Middletown, Ohio.

Ralph W. Noe, formerly graduate student at the New York State College of Forestry, is now a chemist at the Forest Products Laboratory, Madison, Wis.

Bruce Otis is now Assistant to the President of the Black-Clawson Co., New York, N. Y.

Stewart Otto, formerly of Hudson Pulp & Paper Co., is now a project supervisor for Union Bag-Camp Paper Corp., Hoboken, N. J.

Paul L. Page, formerly of Imperial Paper & Color Corp.,

is now a technical representative of the Synthetics Department of Hercules Powder Co., Cleveland, Ohio.

John R. Parkinson, formerly of Cascade Kraft Corp., is now Director of Fiber Research, Seattle, Wash.

Charles E. Payne, Jr., industrial engineer with the St. Regis Paper Co., has been transferred from Jacksonville, Fla., to Deferiet, N. Y.

Rohe V. Pennington, formerly of Owens-Illinois Glass Co. Mill Division, is now an engineer with Improved Machinery Corp., Nashua, N. H.

C. Cline Peters is now Vice-President in Charge of Manufacture for Riegel Paper Corp., Riegelwood, N. C.

Gordon W. Pixler, formerly of the Air Reduction Co., is now paper chemicals technical sales service for Heyden Newport Chemical Corp., Pensacola, Fla.

John C. Randall, formerly of Ecusta Paper Div., Olin-Mathieson Corp. is now a research assistant and graduate student at North Carolina State College, Raleigh, N. C.

Bengt G. Ranby, formerly director of the Empire State Paper Research Association, is now with the Royal Institute of Technology, Department of Polymer Technology, Stockholm, Sweden.

John D. Reagh, Jr., of the Weyerhaeuser Co. has been transferred from Everett, Wash., to Longview, Wash., as Research Director.

George Ries, formerly of Western Machinery Co., is now Product Manager of the Chicago Pump, Hydrodynamics Division, FMC Corp., Chicago, Ill.

Charles C. Rippberger, formerly of Thurso Pulp & Paper Co., is now a project engineer with Parsons & Whittemore Co., Paris, France.

Warren S. Rushton, formerly of Brown-Bridge Mills, is now in the research department of Fitchburg Paper Co., Fitchburg, Mass.

James Sackellares is now Technical Director of Southern Paperboard Division, Continental Can Co., Port Wentworth, Ga.

William F. Scanlan, formerly of the Whiting Corp., is now a chemical engineer with Richard M. Armstrong Co., West Chester, Pa.

W. Allan Schenk is now Vice-President in Charge of Manufacturing for Riegel Paper Corp., Milford, N. J.

Hans Schwab of Escher Wyss is now with Tallers Coghlan S.A., Munro, Argentina.

Rolf Serenius, formerly of Nekoosa-Edwards Paper Co., is now Technical Service Manager for Macmillan Bloedel & Powell River, Ltd., Powell-River, B. C.

Gordon R. Stephen, formerly of Ross Engineering of Canada, Ltd., is now Paper Mill Sales Manager for J. O. Ross Engineering Division, New York, N. Y.

Edward E. Stephenson, Jr. is now Production Services Manager for Sutherland Division, KVP Sutherland Paper Co., Kalamazoo, Mich.

Rolland F. Sultze, formerly of Simpson Timber Co., is now Manager of Research and Development for Northwest Paper Co., Cloquet, Minn.

C. Lester Tomlinson is now Manager of Pulp Development for Dominion Tar & Chemical Co., Ltd., Kraft and Fine Paper Group, Montreal, Que.

James G. Wakefield, Project Cost Engineer of St. Regis Paper Co., has been transferred from Tacoma, Wash., to Jacksonville, Fla.

Laurence T. Waterman, formerly of St. Regis Paper Co., is now Sales Manager for Northeast Constructors, Inc., Gouverneur, N. Y.

Robert L. Wise of Dow Chemical Co. has been transferred from Midland, Mich., to Gales Ferry, Conn., as coatings customer service chemist.

* * *

Moh Barmawie Alwie, Managing Director, has succeeded **K. Krideharsoje** as the official corporate representative in TAPPI of Bank Pembangunan Indonesia, Djakarta, Indonesia.

* * *

William H. Shockley, official representative of Reichhold Chemicals, Inc., in the Technical Association, has moved his office from White Plains, N. Y., to Appleton, Wis.

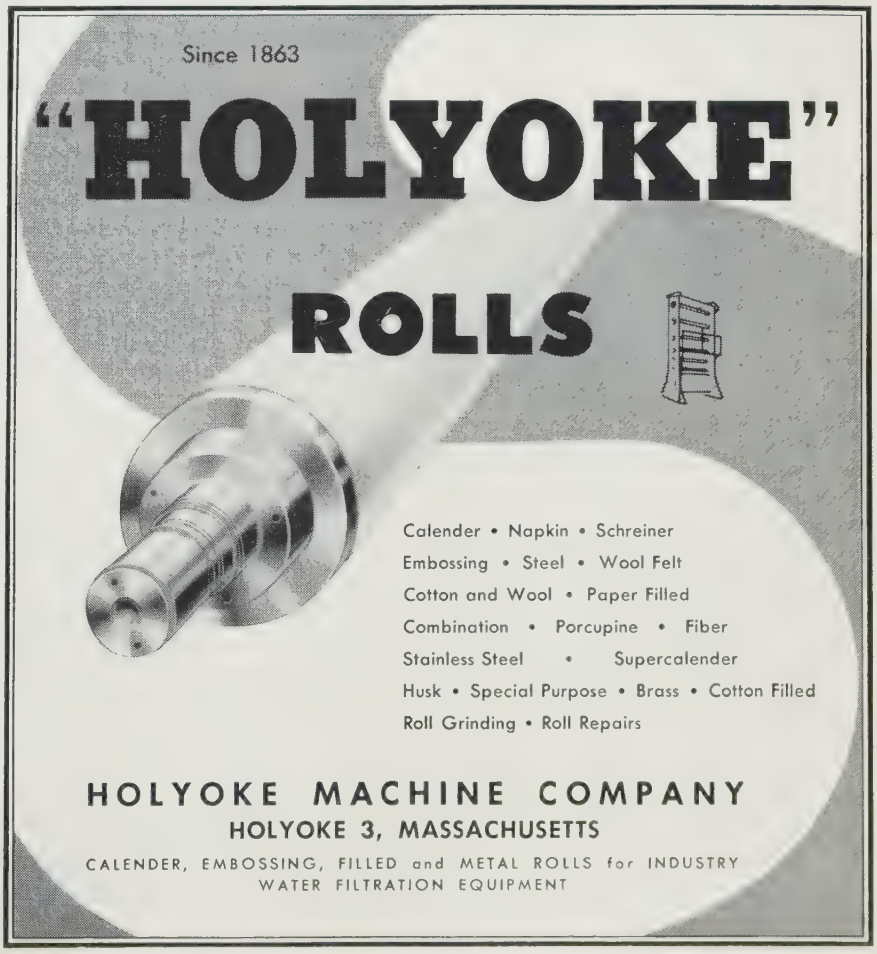
Claude A. Raby, Divisional Manager, has succeeded **R. J. Casey** as the official representative of J. M. Huber Corp., New York, N. Y., in TAPPI.

James I. Munson, General Sales Manager, has succeeded **Daniel J. Saunders,** retired, as the official representative of the Permutit Co. Div. of Pfaudler-Permutit, Inc., New York, N. Y., in TAPPI.

The name of the Appleton Woolen Mills has been changed to Appleton Mills, Appleton, Wis.

Annual Meeting Authors Attention

Deadline for Abstracts and Manuscripts
Jan. 1, 1962


Since 1863
"HOLYOKE"
ROLLS
Calender • Napkin • Schreiner
Embossing • Steel • Wool Felt
Cotton and Wool • Paper Filled
Combination • Porcupine • Fiber
Stainless Steel • Supercalender
Husk • Special Purpose • Brass • Cotton Filled
Roll Grinding • Roll Repairs
HOLYOKE MACHINE COMPANY
HOLYOKE 3, MASSACHUSETTS
CALENDER, EMBOSSING, FILLED and METAL ROLLS for INDUSTRY
WATER FILTRATION EQUIPMENT

INDUSTRY NOTES

Paper Manufacturers and Converters

N. V. Berghuizer Papierfabriek, voorheen B. Cramer

250th Anniversary

To celebrate the 250th anniversary of the N. V. Berghuizer Papierfabriek, voorheen B. Cramer, a festive afternoon gathering was held on September 14, in one of the new wings of the plant in Wapenveld. The most eminent guest was H.R.H. the Prince of the Netherlands. There were more than 500 people present, among whom were many guests from abroad.

After a welcome by B. Cramer, one of the firm's directors, an address was given by the Queen's Commissioner for the province of Overijssel, H. W. Bloemers. He announced that H.M. the Queen had graciously conferred on the firm the right to use the title "Royal." The speech of the day was given by Prof. C. Northcote Parkinson.

Before the reception, the guests were given time to see the factory. In order to give an impression of the uses of paper in packing provisions, a model self-service shop had been built on the premises. This model, which was very popular with the guests, will remain here for six months.

The festive gathering closed with a performance of "Papyrika," a play specially written for this occasion. With this play—an ode from man to paper—the sample collection 1961, of the Berghuizer Papierfabriek, was presented in a lighter vein.

The 15th and 16th of September were festive occasions for the personnel and the local community. The firm gave *f.*100,000. to the people of Wapenveld and district to build a swimming pool.

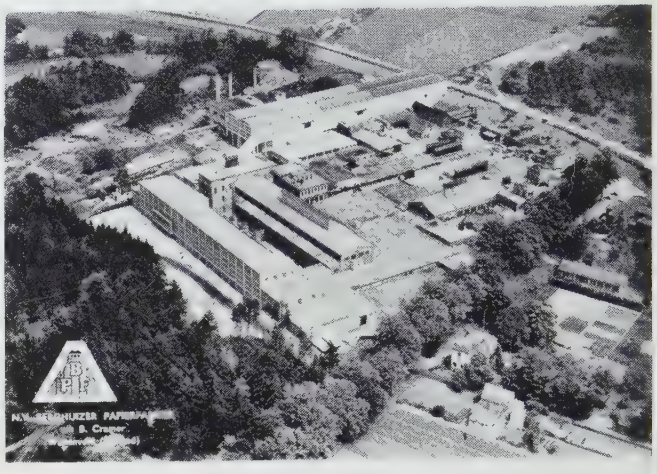
History and Development

The factory is situated in the northeastern part of the Province of Gelderland in a region of heathland, commons and pine woods, called the "Veluwe," one of the most beautiful in the Netherlands. The papermaking industry has long been established in this area, the first mills having been erected 200 to 300 years ago. The main reason why the industry settled there was that the water from local streams could provide the motive power for the paddle wheels that drove the mills.

Although the site of the factory is now at Wapenveld, the company did not originate there, but in the hamlet of Mander, near Ootmarsum. It was here that the founder of the company, Bernard Kremer, a lawyer from Ootmarsum, started his paper mill in 1711. Ootmarsum lies about 45 miles to the east of Wapenveld, quite near the German frontier. In 1715 the name Kremer, which until then had been spelled in all manner of ways, was changed to Cramer, and to this day the name B. Cramer can be found in the company's official style.

The business in Ootmarsum expanded steadily until, about 100 years after its foundation, five mills were in operation with a combined daily output of some 400 kg. of paper.

While previously paper had been made by hand, in 1867 the first cylinder-mold machine was installed, which was, moreover, the first machine of its kind in the Netherlands. At that time the business was being run by G. W. Cramer and H. G. D. Cramer. The raw materials for the imitation handmade paper manufactured on this machine were rags and scrap paper. The product found a ready sale, and in 1870 it was decided to install a fourdrinier machine with drying cylinders, together with a steam engine to provide the necessary motive power, which until then had been supplied by five paddle-wheels driven by water from the streams.



N. V. Berghuizer Papierfabriek v/h B. Cramer plant at Wapenveld, Netherlands

The new machine was put into operation on Feb. 17, 1871. In 1870 the Franco-German war had broken out and there was a great demand for paper in Germany. The factory's location close by the German border enabled a good trade to be done. However, the postwar years saw the evolution of Germany's own industry and this had its repercussions on the Ootmarsum business, and one of the papermaking machines even had to be sold to Germany.

Communications with the rest of the Netherlands were too bad in those years to allow the factory to compete with firms established in the Veluwe and in the Zaan District to the north of Amsterdam.

G. W. Cramer was appointed burgomaster of Ootmarsum and retired from the firm. H. G. D. Cramer carried on the business alone, and concentrated on the production of strong and fine-quality papers. In 1876 the firm took part in an exhibition at Philadelphia, and at this and at nine subsequent exhibitions the company's manufactures were awarded either gold medals or prizes. Furthermore, notwithstanding keen German competition, the Ootmarsum product was chosen for cartridges supplied to the Bavarian Government.

However, in about 1880 very high protective tariffs were imposed in Germany, which made it practically impossible to sell there. In view of the inadequate communications with the rest of the Netherlands and the scanty market in the east of the country, it became necessary to transfer the business elsewhere. In 1884 the paper-mills "Berghuizen" near Wapenveld came up for sale, and on May 28 of that year the factory was bought by H. G. D. Cramer. Machines were brought over from Ootmarsum and the first pages in the history of the company, the Ootmarsum era, were closed.

Production was resumed as quickly as possible in the Wapenveld factory; with the machines that were already installed there and those that had been transferred from Ootmarsum, the manufacture of board and wrapping paper began. The products sold well and this meant that the factory could gradually be enlarged and modernized. In 1888 J. Sligcher was taken into the business and appointed co-director.

On Sept. 20, 1898, a fire broke out in the board-drying shop and the whole factory was reduced to a heap of rubble. It

was decided to rebuild at once and the construction of a factory, of much larger proportions, was put out to contract.

In the course of the years the company has been continually expanded and modernized. By way of illustration, in 1906 the second paper machine was installed, in 1910 the third, in 1923 the fourth, in 1926 the fifth, in 1929 the sixth, and in 1956 the seventh. A short while ago it was decided to expand production capacity even further by placing an order for a new papermaking machine, making a total of eight. Delivery of this new machine should be taken in the autumn of 1963. The papermaking machines, the preparing machines, the auxiliary machines, etc., are all electrically driven. Part of the electricity used is generated on the premises; the rest, and the larger part, is supplied by the regional electric company.

In 1899 it was decided to turn the firm into a limited company, and the name was changed to "N. V. Berghuizer Papierfabriek, late B. Cramer." The management consisted of H. G. D. Cramer and J. Sligcher. The year 1899 also saw the introduction of nonstop production with both a day- and a nightshift.

The present management comprises B. Cramer, Jr., and W. F. Zetteler. Mr. Cramer is a descendant of the founder, Bernard Cramer, so that the management of the business has been in the hands of one family for 250 years. The two ex-directors, B. Cramer, Sr., and D. Cramer, still show an unfailing interest in the fortunes of Berghuizer. Both are attached to the company in an advisory capacity. The supervisory board is composed of four members. The company has a staff of more than 700, the paper production is semicontinuous.

The total paper production in 1960 amounted to more than 34,000 tons. The manufactures consist of wrapping papers in the fullest sense of the words. Besides the ordinary types, there are the finest quality wrapping papers, required to meet the increasing demands made on packings in general and on food packings in particular. The appearance of the finest quality wrapper has become an important selling point, and an attractive packing can only be obtained by using attractive paper.

The paper is delivered from the factory solely in unprocessed and unmade-up condition. It can be supplied in rolls or in sheets cut to size. Part of the production is for the home market and part for export. Home customers include the wholesale trade and industry, which can be divided into manufacturers of paper bags, corrugated cardboard, envelopes, strawboard, the paper processing and other large paper-using

WHITEN
the paper with
PURECAL® O

. . . the Key Chemical so white, it's unique

Because Wyandotte produces Purecal O by a unique double-refining process, it is the whitest of all calcium carbonates. It is also unusually opaque. The result is that it can replace appreciable amounts of TiO_2 in coatings without loss of whiteness or hiding power . . . cover even off-white base stocks beautifully. Try it.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

industries. Exports account for 8 to 10% of the total production.

As has already been mentioned, the firm was made a limited company in 1899. Initially, the shares were in the hands of the management and members of the family only. Today, there are two types of shares: first, the priority shares, which are held only by the management and the supervisory directors, and, secondly, ordinary bearer and registered shares, which are in the hands of private persons, investment companies, etc. The bearer and registered shares are dealt in on the Stock Exchange.

The company holds practically all the shares in a large processing company in Rotterdam, N. V. Cats Neparofa. This concern, which is engaged in the processing and making up of paper, and in the wholesale trade in paper, maintains a staff of some 750 employees.

In connection with the increasing need for space for the manufacture of special wrapping materials at the Cats Neparofa factory in Rotterdam, a modernly equipped manufacturing company, N. V. Monopole at Rhoon, was acquired during the past financial year. This purchase has prevented an interruption in the existing program for the processing of the numerous types of paper. The company at Rhoon is only a few miles from Cats Neparofa.

The Berghuizer Papierfabrick also holds part of the shares in Mopavi at Rotterdam. Mopavi manufactures paper milk containers, paper beakers, and similar articles.

Bowater's Newfoundland Pulp & Paper Mills, Ltd.

Salvage of Wood in Newfoundland Fire Area

Bowaters will be able to salvage a good deal more than half the wood in its burned-off areas in Newfoundland, according to Sir Eric Vansittart Bowater. The chairman of the world-wide Bowater Organization spoke following an aerial inspection of the forest fire regions of the province.

A great salvaging operation is to be organized early this autumn. "After a normal fire, we are usually able to salvage the bulk of the wood, which may be cut up to six years after the fire without loss of quality. In this case, due to the size of the burn and to the difficulty of access to some parts of the area involved, we may have to be content with something less.

"However, I shall be most disappointed if substantially more than half the wood cannot be sucessfully harvested, both on Crown lands and on our own timber limits," said the chairman.

Fires on the Bowater timber limits, which cover less than half total area burned, are now all contained, the chairman said, following his inspection tour. However, there is still one serious fire out of control at Fortune Bay to the south, and Bowater's fire fighting teams remain at the call of the Government.

The first early assessment of the damage indicates that the burned areas cover some six per cent of the Bowater timber limits in Newfoundland. These are largely in one of the districts from which it was hoped to supply the Bowater mills in the United Kingdom.

However, the chairman stressed, there will be no interruption, now or in the future, to the supply of wood necessary to maintain full operation of either the Corner Brook or United Kingdom mills.

Sir Eric paid "highest tribute to the magnificent work in fighting fires that has been organized by Premier Smallwood and his Government under Hon. W. J. Keough, Minister of Mines and Resources.

Bowaters Southern Paper Corp.

T. C. Bannister, Jr., R. Bruce Reid, and **George C. Davis** have been elected to the Board of Directors of Bowaters Engineering and Development, Inc., Calhoun, Tenn. The announcement of new board members was made recently by G. P. Hobbs, president of Bowaters E & D.

Brown Co.

The executive and general sales offices of Brown Co., diversified manufacturer of pulp, paper and related products, was moved to New York City at the end of September. The offices were formerly located at 150 Causeway St. in Boston, and the company has maintained a branch sales office at 500 Fifth Ave., New York.

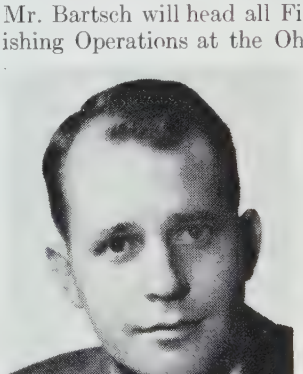
Location of the company's new headquarters is 733 Third Ave. at 46th St., in one of New York's newest office buildings.

Champion Papers, Inc.

The assignment of three men to top level positions in the Ohio Division of Champion Papers, Inc., has been announced by Earl C. Jones, Division Manager of the local company. **Robert O. Stephenson** has been promoted to assistant Ohio division manager. **William E. Larson** has been appointed as acting production manager, and **Perry W. Bartsch** has been named as acting manager of Finishing Departments.

Robert O. Stephenson, Champion Papers, Inc.

In his new assignment, Mr. Stephenson will directly assist Mr. Jones in all phases of Champion's Ohio Division operations. Mr. Larson will now be responsible for all production at the Hamilton plant. Mr. Bartsch will head all Finishing Operations at the Ohio Division as well as continue his present assignments for the firm's General Office.



William E. Larson, Champion Papers, Inc.

Perry W. Bartsch, Champion Papers, Inc.

Columbia Box Board Mills, Inc.

Robert R. Howarth, president of Columbia Box Board Mills, Inc., of Chatham, N. Y., has announced the appointment of **Joseph J. Fiori** to the position of assistant to the president. Mr. Fiori was previously with Gibralter Paper Box, North Bergen, N. J.; Shartle Brothers Division of Black-Clawson, Middletown, Ohio; and Stone Container of Chicago, Ill. Prior to joining Columbia Box Board Mills, Mr. Fiori was manager of mills for Hinde and Dauch, Toronto, Canada.

Consolidated Paper Corp., Ltd.

The following recent appointments to the Research and Development staff of Consolidated Paper Corp., Ltd., Grand Mere, Que., have been announced.

F. E. Murray, formerly with the British Columbia Research Council in Vancouver, has been appointed research coordinator. **O. J. Walker,** formerly chief development engineer and later technical director of Anglo-Canadian

Pulp & Paper Mills, Ltd., has been appointed development coordinator. **W. T. Houghton,** recent M.Eng. graduate in chemical engineering from the University of Delaware, has been appointed research engineer in the By-Products Group. **J. L. Barlow,** a recent B.Eng. graduate from the University of Toronto, has been appointed research engineer in the Engineering-Physics Section.

CONSOLIDATED WATER POWER & PAPER CO.

Richard J. Gunderman has joined the Research and Development Division of Consolidated Water Power & Paper Co., it has been announced recently by S. G. Holt, research manager.

CONTINENTAL CAN CO.

Technical Center

The Technical Center, Continental Can Co.'s $20,000,000 packaging research complex, was officially opened in September in Plainfield, Ill.

The new Center consolidates research activities for all but one of Continental's product divisions in close proximity to each other and to the long-range research operation at Central Research and Engineering.

In effect, the company has brought together the most capable scientists, engineers, and technologists from widely separated research facilities throughout the United States. These men, all authorities in the field of packaging research, have been given the finest equipment available to work with, and are housed in four specially designed buildings laid out to provide sufficient space in which to set up experimental machinery, production pilot lines, and testing instruments.

Newly operating in the Technical Center are the General Packaging Research and Development Laboratory, located next to Continental's previously established Metal Research and Development and Central Research and Engineering facilities, and the Glass Research and Development Laboratory, an hour's distance away in Plainfield, Ill., across the road from the company's newest glass container manufacturing plant.

Buildings

The four buildings making up the Technical Center house a total of some 800 scientists and technicians in an area covering 553,000 sq. ft., or nearly 13 acres of research facilities.

The General Packaging Research and Development Laboratory combines the scientific and engineering talent of six of the company's divisions: Bondware (paper container); Corrugated Container; Flexible Packaging; Folding

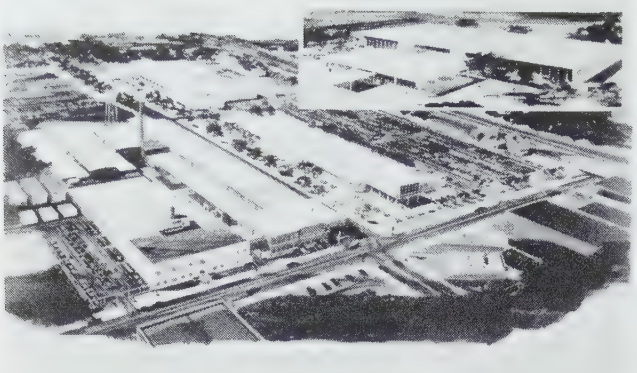
BRIGHTEN
the picture with
PURECAL® O

. . . the Key Chemical so pure, it's unique

Wyandotte Purecal O is the one calcium carbonate that contains no impurities to rob colors of their clarity. It is also grit free. For these reasons, among others, it is a remarkable coating pigment that provides a perfect background for color reproduction . . . and at the same time protects plates from wear. Try it.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN



Continental Can Company officially opened its Technical Center in Chicago and in Plainfield, Ill., on September 14. The three buildings that comprise the Chicago portion of this packaging research complex include Metal Research and Development, General Packaging Research and Development, and Central Research and Engineering. Inset shows Glass Research and Development building in Plainfield

Carton and Fibre Drum; Plastic Bottle and Tube; and White Cap and Bond Crown (closures).

General Packaging

General Packaging Research and Development Laboratory is devoted to research on paper and plastics for packaging, and to metal closures, with the most complete and elaborate facilities available anywhere for such experimentation. The new laboratory consolidates research for six product divisions: Flexible Packaging, Corrugated Container, Folding Carton and Fibre Drum, Bondware (paper container), White Cap and Bond Crown (closures) and Plastic Bottle and Tube.

In an area of 145,000 sq. ft., located adjacent to the firm's Metal Research and Development Department and across the street from Central Research and Engineering, a 300-man research organization housed under one roof can share special equipment and technical knowledge not previously possible when the facilities were geographically scattered. The laboratory is headed up by Dr. Robert B. Mesrobian. Each product division conducts its own research and engineering activities, while certain other projects have a common base.

Cooperation on developments is also attained with the company's other research elements.

Major emphasis of General Packaging Research and Development is toward new container development and improved converting operations by use of more efficient processes and equipment. To provide added technical services for the product divisions, the materials formulation and evaluation department has been formed. It deals with research on coatings, inks, sealants, extrusion plastics, materials testing and toxicological measurements. The process engineering department has been formed for the purpose of supplying each of the product divisions with new processes and converting methods. In this department are groups devoted to automation and instrumentation, stress analysis, statistics, process economics and advanced machine design as required to place the current converting operations on the highest level of efficiency.

As for the interests of the individual product groups within General Packaging Research and Development, each has a number of immediate projects under investigation.

CCC's Flexible Packaging Division supplies materials to package a large number of the 4000 flexible-packaged items Americans now use in their daily lives. Of these items approximately 70% are food. Packaging materials include paper, foil, plastics, and combinations of these.

Research in this division is focused largely on developing new flexible packaging and improving standard products insofar as function, customer appeal and costs are concerned. The research group investigates and evaluates raw materials, including plastic films, metal foils, papers, adhesives, lacquers, inks, solvents, and pigments. It develops new processes and methods for printing, laminating, extruding, heat sealing, vacuum metalizing, coating and drying paper and films and foil and converting these into bags, roll stock and related products.

Folding Carton and Drum Division's research deals with boxboard and improvement of its chemical and physical properties by coating and printing developments, along with carton design and equipment for converting boxboard into folding cartons. A major future development appears to involve the direct conversion of paper pulp into a container without the necessity for going through the papermaking stage.

It is also concerned with development of special seamless plastic inner linings for fiber drums in order to increase the range of liquid products that can be satisfactorily packaged. Recent advances enable drums to hold citrus concentrates and vegetable lards. Performance of fiber drums under all kinds of conditions is evaluated. Among facilities used for this purpose are humidity chambers, submission and compression testers, shower testers, drop-testing equipment and refrigeration cabinets.

Research on corrugated boxes involves studies as to the proper geometry of the corrugated structure to obtain maximum mechanical strength as well as investigation of proper chemicals and coatings to increase the chemical resistance and functionality of the boxes.

The Bondware Division is concerned with the manufacture of paper cups, plates, and food tubs. Research here is active in the further development of these components made entirely of paper or plastic, or from combinations of paper and plastic.

The Plastic Bottle and Tube Division is interested in new uses for plastic bottles and molded plastics generally.

The White Cap and Bond Crown Division deals with closures such as the easy-to-open and reseal vapor vacuum closing system and the familiar White vapor-vacuum caps, as well as bottle crowns. Now under investigation are all-plastic closures, which have proved valuable for such household items as laundry bleach and ammonia. Colored plastic caps also are in development due to the marketing advantages they offer.

Glass R&D

The new Glass Research and Development building, working for the Hazel-Atlas Glass Division of the company, is devoted to advancing technology for the world's oldest packaging materials.

Metal R&D

The Metal Research and Development facility, the first and largest of them all, concentrates upon new and improved metal containers and fabricating equipment designed to lower cost, increase speeds, and improve quality.

Central Research and Engineering

Basic research to insure Continental Can Co.'s leadership in packaging five to ten years and more in the future is the responsibility of the Chicago facility known as Central Research and Engineering.

Here in an area of 78,000 sq. ft. filled with the most complex and precise instruments for scientific experimentation and measurement, 75 top level scientists, with a nontechnical supporting staff of 34 and two patent attorneys, concentrate on developing and finding proper applications for radically new materials, methods, equipment, and products in the packaging field.

Central R & E has no contact with customers or directly

with manufacturing plants. It is nevertheless skillfully integrated with the various divisions' research and development efforts, more effectively so, now that Continental's entire research complex is housed in the Chicago area. Central Research scientists can much more easily familiarize themselves with current product division research projects. They are available for more frequent consultation when the need arises and can be advised of potential projects of a radically new nature which cannot be investigated at product division research headquarters.

Thus, Central R & E long range programs may originate from (a) top management, (b) ideas of Central's own personnel, (c) the product divisions, or (d) ideas brought to them from the outside.

The Central Research and Engineering Division, in addition to the consulting research and engineering services which it renders the product divisions, also coordinates all divisions' investigations of the toxicological safety of packaging materials, preparing the data for the Food and Drug Administration and for other federal agencies. The division's staff are members of many important scientific committees concerned with the safety of packaging and foods.

In addition to retaining the services of outstanding consultants in its specialized fields of interest, the Central Research and Engineering Division also supports basic research by grants of company funds to educational institutions, as well as by purchase from technical institutes and independent laboratories.

What the Technical Center Means

The only packaging manufacturer able to produce packages from every available material, Continental becomes the first to bring together into a single area a team of scientists, engineers, and technologists combining both basic scientific knowledge and specialized experience in every phase and segment of the industry.

"Continental has the right package for you" becomes more than a motto; it is the generating force of Continental Can Co., world's largest packaging manufacturer—the reason behind the company's $20,000,000 Technical Center.

FLINTKOTE CO.

Container Plant in Magnolia, Miss.

The Flintkote Co. recently formally started up production at its new $2 million corrugated container plant at Magnolia, Miss. The Magnolia plant is a one-story concrete structure comprising 115,200 sq. ft., situated on 14 acres of land, adjacent to U. S. Route 51. It is serviced by the Illinois Central Railroad with a siding that will accommodate eight railroad cars for simultaneous loading. The plant is within two

SHARPEN
the image with
PURECAL® O

. . . the Key Chemical so uniform, it's unique

Purecal O particles are uniform in size and shape . . . ideal in size and shape to give paper coatings the smoothness for clean, quick acceptance of fine impressions. These special properties are all traceable to Wyandotte's unique precipitation process. No other produces calcium carbonate like Purecal O. Try it.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

miles of an entrance to the new Super Interstate Highway 55 now under construction from New Orleans to Chicago.

Facts and Figures about Magnolia Plant

The plant, incorporating latest machinery and equipment, has a potential capacity of 50,000,000 sq. ft. of corrugated paper products per month. Functionally designed, it is fully equipped with conveyors to handle corrugated board from the manufacturing to shipping.

All new developments available to the corrugated box industry for the high-speed quality production of corrugated paper products have been incorporated into the one-story building. When production is on a two-shift basis, expected employment will be between 110 and 130 persons.

An unusual piece of equipment is the 78-in. Hooper Swift high-speed corrugator equipped to make A or B flute, or double wallboard. Fully equipped the Hooper can be operated at speeds up to 600 lineal f.p.m. of finished board.

A new Signode semiautomatic compression and strapping machine expedites the assembly and binding of finished cartons and other finished corrugated paper products.

A Cyclomatic baler, in a continuous, automatic operation, handles the scrap trim generated at various points throughout the plant. The scrap is blown pneumatically through galvanized ducts into the machine which bales continuously.

Steam for the corrugator is supplied by two fully automatic package boilers which are capable of generating a 200 lb. steam pressure within 10 sec.

The roll-stock storage area of the plant has a 22-ft. ceiling and can hold a 3000 ton inventory of 60-in. diam. corrugated paper rolls.

The plant is equipped for a complete design and sample-making department as well as testing facilities necessary to maintain a constant check on board and product quality.

A fully enclosed concrete, block-walled room has been provided for the mounting and storage of rubber and plastic printing dies. This area will have controlled temperature and humidity for better preservation and control of dies kept in inventory.

Located in the middle of the modern plant, and adjacent to the corrugator and roll stock area, is the full enclosed concrete block-walled machine shop. This shop is completely equipped to handle the maintenance necessary for the economical operation of the plant.

Space heating of the plant is effected by individual gas-fired heaters thermostatically controlled to perform the heating practical for the area in which they are located.

INTERNATIONAL PAPER CO.

Tree Farm

A group of state officials headed by Gov. John H. Reed, joined with industry representatives on September 15 to dedicate 126,000 acres of woodlands and waterways as Maine's largest Tree Farm.

The area, which is owned by International Paper Co., is located north and west of Caribou, and embraces the Fish River chain of lakes. Certification as a Tree Farm means that these tax-paying forest acres are being managed according to specified standards and have been devoted to the growing and harvesting of repeated forest crops.

In addition to the Tree Farm, a new public boat launching ramp was dedicated on Cross Lake. Built by International Paper in conjunction with Sportsmen, Inc., of Caribou, the new ramp is designed to facilitate public access to the area's state-operated campsites, lunch grounds and picnic spots and to its 118 miles of lake front.

Container Div.

International Paper Co.'s Container Division has announced that **W. S. McDonald,** with the company since 1937 when he joined the Southern Kraft Division, has been named assistant general superintendent for the division.

KIMBERLY-CLARK CORP.

Bolton Award Essay Contest

At a luncheon held recently at the K-C Marketing Center in Neenah, Wis., **Andrew J. Rego,** a management trainee in the Main Office Purchasing Department of the Kimberly-Clark Corp., received a check for $500 and a hand engrossed, laminated wall plaque for his third place winning entry in the 14th annual Bolton Award essay contest.

KVP SUTHERLAND PAPER CO.

Edward E. Stephenson has been named production services manager for the Sutherland Div. of KVP Sutherland Paper Co. Mr. Stephenson joined the Sutherland Division in 1951 as a chemical engineer. He held the position of Staff Technician in charge of Paper Testing and Paper Specifications and since 1956 has been Director of the Quality Department.

MOSINEE PAPER MILLS CO.

C. M. Green has been elected president and general manager of Mosinee Paper Mills Co. He was executive vice-president and general manager for the past two years. Mr. Green began his employment with the Mosinee, Wis., firm in 1925 in the pulp mill. He successively was a chemical laboratory technician, engineering department draftsman, plant engineer, safety engineer, purchasing agent, and plant manager. In 1957 he was elected vice-president and general manager.

RIEGEL PAPER CORP.

F. S. Leinbach, president of Riegel Paper Corp., has announced the appointment of **C. W. Barr** as divisional vice-president and general manager of the Folding Carton Division, reporting to Mr. Leinbach. At the same time new titles were also announced within other company divisions.

In the Paper Division, G. L. Bidwell, Jr., vice-president—general manager, made the following appointments: **W. M. Riegel,** sales vice-president, and **W. A. Schenck** manufacturing vice-president.

In the Pulp and Paperboard Division, C. E. Hartford vice-president—general manager, made the following appointments: **Winthrop Endicott,** sales vice-president, **J. B. Lattay,** woodlands, vice-president, and **C. C. Peters** Manufacturing Vice-President.

In the Flexible Packaging Division, J. Hanes Lassiter vice-president—general manager, made the following appointments: **E. N. Leonard,** manufacturing vice-president, **N. W. Postweiler,** sales vice-president, Flexible Packaging Sales Dept., **J. V. Shea,** sales vice-president, Lassiter Sales Dept., and **L. W. Weller,** vice-president and executive assistant.

OWENS-ILLINOIS GLASS CO.

The appointment of **James W. Hackett** as Administrative Division vice-president and director of engineering and research for Owens-Illinois Glass Co. has been announced.

OXFORD PAPER CO.

General

Many factors were involved in the Oxford Paper Co.'s decision to make major changes in their pulping facilities. Among the more important were:

Unlimited utilization of their wood reserves.
Maximum pulp strength and cleanliness.
Increased pulp brightness.
Increased pulping capacity.
Major reduction in stream pollution.
Self-sufficiency in respect to pulp supply.
Economics associated with the substitution of hardwood pulp and quality advantages of softwood kraft over sulfite.
Recovery of lime and modernization of causticizing process.

The pulp mills in 1959 included a 160-ton-per-day sulfite mill cooking spruce, fir, and hemlock which furnished the softwood requirements, a 260 ton-per-day kraft mill cooking mixed northern hardwoods and a 70 ton-per-day groundwood mill. In addition the company had a second 130 ton-per-day sulfite mill which had been shut down but which was activated during the construction program. The pulping program included replacement of the sulfite mill with a 175 ton-per-day softwood kraft mill, expansion of the hardwood mill to 350 ton-per-day and no changes in groundwood operation. In addition to its own pulping capacity the mill purchased substantial quantities of high brightness long fibered kraft to reinforce the lower strength sulfite when required. The brightness level on both chemical pulps was approximately 81 as dictated by existing bleaching facilities. To raise the brightness level to a required 86 to 88, the old sulfite bleachery was replaced and the existing hardwood bleachery extended. The liquor recovery system designed for 260 tons of hardwood kraft was extended and modified to accommodate the addition of softwood kraft and additional hardwood production.

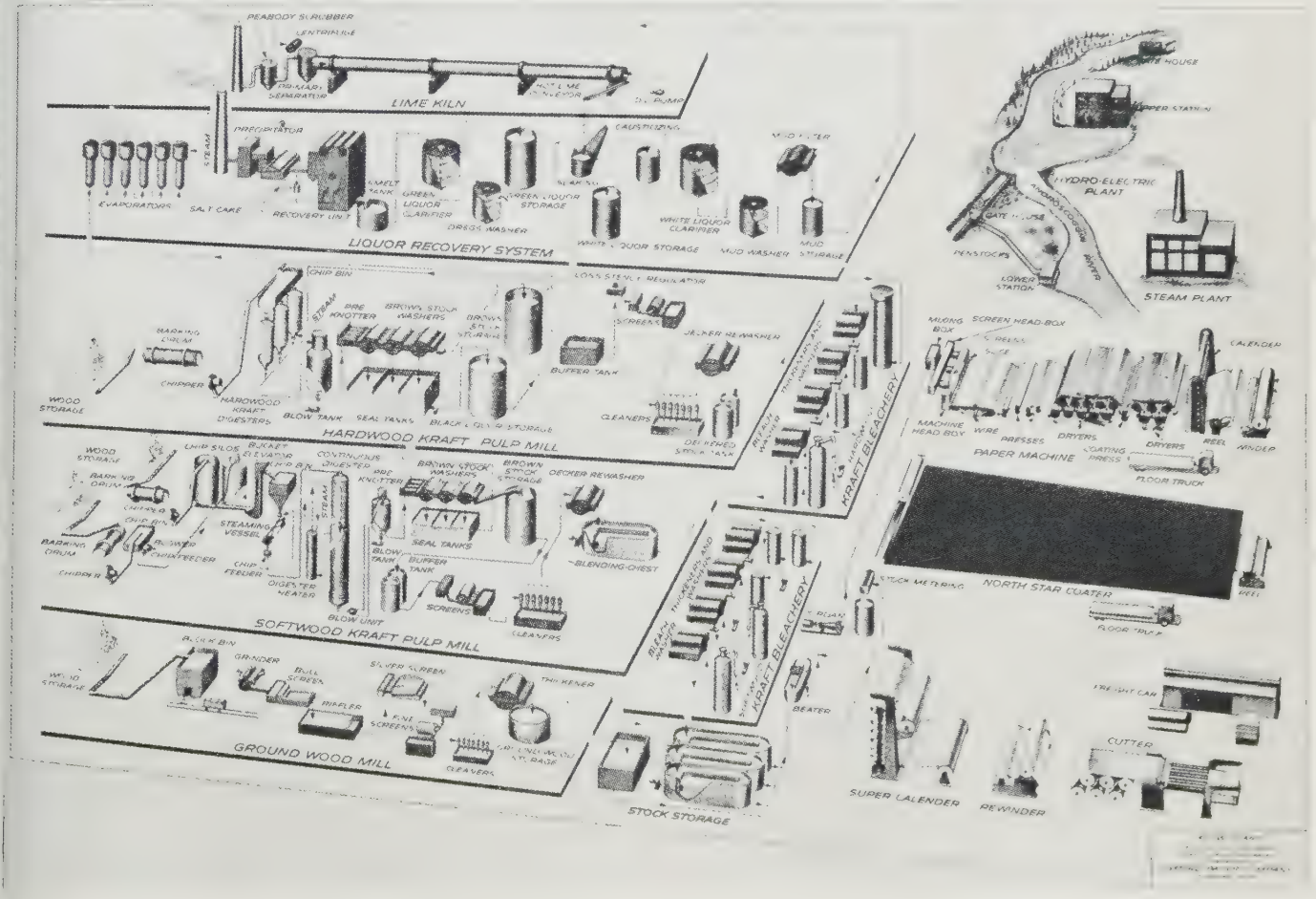
The hardwood facilities were placed in operation July, 1960, and the softwood mill started July, 1961. Expected tonnages and pulp quality specifications have been met or exceeded. Minor problems associated with a new operation are being encountered and corrected as they occur.

Wood Supply and Processing

The pulp wood supply for the mill includes both hardwoods and softwoods. The local hardwood supply of beach, birch, and maple is adequate. However, cutting of spruce and fir used by the old sulfite process had exceeded growth and it was desirable to draw on other species. Substitution of the kraft process for sulfite permitted the use of additional hemlock as well as making it possible to use local pine and saw mill waste in the form of chips. The chips are purchased and introduced into the softwood stream.

Pulp wood is received at the mill by truck or rail as either rough or peeled wood in 4-ft. lengths. Mixed hardwoods are handled through the existing barking plant and wood room which were adequately sized to handle the increased capacity without change. Accepted chips are conveyed by belt to the feeder of a pneumatic conveying system. Hemlock is handled through an existing softwood drum and through the existing wood room which was renovated. While pine roundwood is currently not being used at a later date it can be proportioned to the hemlock and sent through the same system. Wood from the barking drum or peeled wood from cars or trucks is fed by a new conveying system to an existing Murray chipper. Chips are screened through a new Orville Simpson Model No. 72 "Rotex" chip screen.

Accepted chips are conveyed by belt feeder to a pneumatic conveying system. The rejects are rechipped and then returned to the chip screen feed. Sawdust from the screening system joins the bark from the drums and is burned in an existing refuse burner. A new hydraulic horizontal Murray chipper was installed to reduce oversized hemlock before chipping. Spruce and fir are handled in common with the groundwood mill at a second wood room at the Island Di-



Flow chart depicting pulp and papermaking at Oxford Paper Co., Rumford, Me.

vision mill located 1/2 mile from main plant. The wood handling, barking, and chipping facilities were adequate and used without change. Accepted chips are conveyed to the feeder of a pneumatic conveying system.

Chips from saw mill slabs and edgings are received by truck or rail at a receiving plant adjacent to the hemlock and pine wood room. These are stored in a 35 by 55-ft. high Neff & Fry concrete stave silo equipped with a Stephen-Adamson rotary plate discharger. The silo discharger feeds a belt conveyor to a "Rotex" screen which discharges accepted chips to the hemlock-pine conveyor to the pneumatic conveying system.

Chip Handling and Storage

After processing in the wood room the mixed hardwood chips are delivered to the feeder of a Radar pneumatic conveyor and are blown to a distributing conveyor serving six existing chip bins over the six stationary digesters. The pipeline is 14-in. diam. steel pipe approximately 300 ft. long and delivers the chips to a cyclone above the distributing conveyor. Conveying air is supplied by a positive displacement blower driven by a 250-hp. motor.

Softwood chips are graded as carefully as possible in respect to species and proportioned into the common stream to the digester. Spruce and fir are received mixed and are chipped together. After screening they are fed to a pneumatic conveying system and fed to one of two 36 by 85-ft. high concrete chip silos. This conveying system has approximately 1900 ft. of 16-in. pipe terminating in a cyclone above the storage silo. The conveying air is supplied by two blowers each driven by 200-hp. motors.

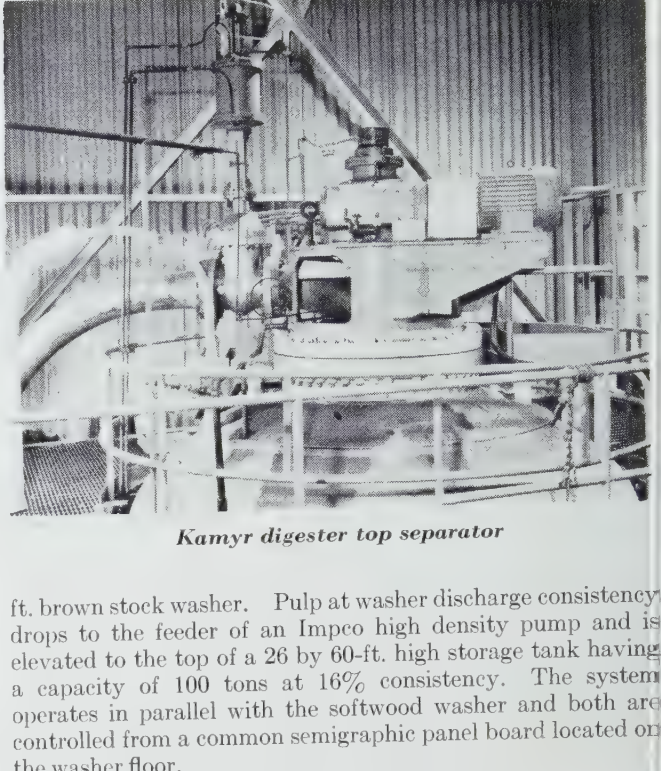
Hemlock is received and processed separately at the present time. If pine pulpwood is used later it will be proportioned to the hemlock and the two species processed together. Purchased waste wood chips, principally pine, join the hemlock stream in controlled quantity and the mixture is conveyed pneumatically to another 36 by 85-ft. high concrete chip silo. This conveying system has approximately 360 ft. of 14-in. pipe terminating in a cyclone above the storage silo. The conveying air is supplied by a blower driven by a 250-hp. motor. Each storage silo has a capacity of 250 cords and was designed to permit week-end shut down of the wood room operation. The concrete walls of the silo were erected by Rust Engineering Co. using the slip form method. Each silo is equipped with a Chain Belt rotary plate discharger and the chip flow is proportioned to a common handling system by adjustment of discharge plows. Chips from the silo are handled through Chain Belt chip elevator and belt conveyors to the storage hopper of the Kamyr continuous digester.

Hardwood Pulping

Hardwood pulp is cooked in six existing forced circulated stationary digesters of conventional design 10 ft.-6 in. i.d. and 42 ft.-3 in. high, having a capacity of 10 tons per blow. The chips are cooked by a schedule to provide optimum balance of strength and printing qualities in the pulp.

Pulp from the digesters is blown to an existing blow tank of conventional design having a capacity of four digester blows. Stock in the blow tank bottom is diluted with black liquor to approximately 4% consistency under control of the agitator power demand. The stock from the blow tank is pumped by a new centrifugal pump equipped with a variable speed drive under control of a magnetic meter. Stock consistency on the discharge of the pump is controlled to 3% by a DeZurik regulator. The controlled flow of stock is then diluted to 1% with black liquor under manual control before entering the knotter head box.

A new hardwood washing system was installed to replace the existing system which was subsequently used for softwood pulp. The system included a three-basket Impco vibratory knotter followed by an Impco three-stage 11 ft.-6 in. by 16-ft. brown stock washer. Pulp at washer discharge consistency drops to the feeder of an Impco high density pump and is elevated to the top of a 26 by 60-ft. high storage tank having a capacity of 100 tons at 16% consistency. The system operates in parallel with the softwood washer and both are controlled from a common semigraphic panel board located on the washer floor.

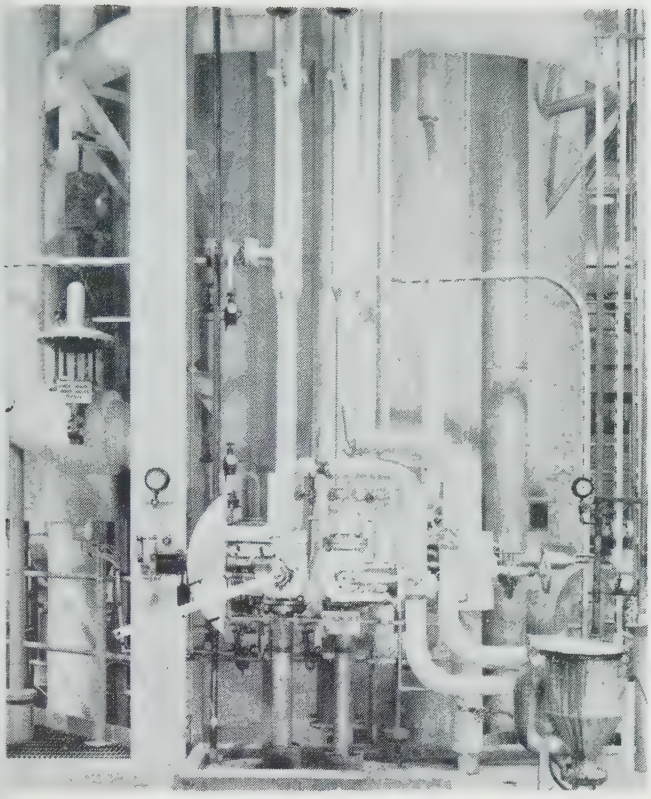


Kamyr digester top separator

The existing screening system consisting of three Trimbey "Senior" screens and 16 type 623 Bauer Centri-Cleaners was retained. A fourth screen of the same design was added and the old gravity deckers were replaced with an 11 ft.-6 in. by 16-ft. vacuum type rewasher. As with the washer the system operates in parallel with the softwood screen room and both systems are controlled from a common panel. Washed and screened stock drops to a small 5% consistency stock tank prior to bleaching.

Softwood Pulping

Softwood pulp is cooked in a new Kamyr continuous digester, 12 ft.-2 in. diam. at the bottom and 90 ft. high, having a nominal capacity of 210 tons per day. Blended chips from the silos are delivered to a small surge bin from which they are fed through a variable speed rotary chip meter to a low pressure feeder discharging into one end of a horizontal steaming vessel. The steaming vessel is 4 ft.-10 in. diam. by 24 ft. long, equipped with a ribbon-type screw conveyor to transport the chips to the discharge end of the vessel. The chips while in the steaming vessel are in contact with low pressure flash steam from the digester flash tank. Chips leaving the steaming vessel drop by gravity to the inlet of the high pressure feeder which charges the digester. The high pressure feeder serves as a seal between the low-pressure steaming vessel and the high-pressure digester. It consists of a four-pocket stainless steel rotor driven by a variable speed drive and rotating inside a pressure vessel. As each pocket attains a vertical position it is filled with chips. When it is rotated to a horizontal position the channel to the steaming vessel is closed and that to the digester is open. Chips in the horizontal channel are flushed with liquor to the top of the digester by means of a circulating pulp. The liquor in which the chips are suspended is separated in the top of the digester by a screen and returned to the suction of the circulating pump. The chips sink to the top of the chip pile inside the digester and the whole chip column progresses downward by gravity. Cooking liquor is introduced through the side of the digester near the top. Midway down the digester the liquor is withdrawn through a stainless bed under suction of a circulating pump, passed through an indirect heater and returned to the digester through a central pipe terminating slightly above the strainer belt. The



Kamyr digester blow valve assembly

process is repeated in a lower zone by identical equipment. The entire digester is kept under hydrostatic pressure. The upper zone is heated to 310°F., the lower zone to 338°F. Retention time at maximum temperature and rated production is $1^1/_4$ hr.

The extreme bottom zone of the digester is utilized to thoroughly cool the charge before blowing. Black liquor from the brown stock washer at 170°F. is introduced through a central pipe, displacing hot black liquor in the digester through two strainer belts on the periphery. The liquor exhausted enters two flash tanks kept at 15 and 0 p.s.i., respectively. The flash steam is returned to the steaming vessel and the concentrated liquor is pumped to the evaporator. The bottom of the digester is equipped with a slow moving variable speed rotary scraper which draws the stock from the periphery of the digester to the central bottom outlet. Stock from the digester at approximately 9% consistency is blown through a metal trap, a blow unit with a rotary scraper, and through one of two blow lines to a blow tank. The controls for the operation are located on a semigraphic panel located on the operating floor of the digester.

The new blow tank for the continuous digester is a closed tank of conventional design. It has an IMPCO agitator in the bottom and operates at nominally atmospheric pressure. Flash steam from the blow is relieved continually and recovered in a heat recovery system. The tank has 1-hr. capacity and is designed to provide a minimum storage between the digester and washer operations. Stock is diluted in the bottom of the blow tank with black liquor to a consistency of approximately 4% under control of the agitator power demand. The stock from the blow pit is pumped by a centrifugal pump equipped with a variable speed drive under control of a magnetic meter. Stock consistency on the discharge of the pump is controlled to 3% by a DeZurik regulator. The controlled flow of stock is then diluted to 1% with black liquor under manual control before entering the knotter head box.

The brown stock washing system which had previously been used for hardwood kraft was an 8 by 16-ft. machine. Operation of this machine had been discontinued when the new hardwood washer was installed. The old machine was completely modernized for use of softwood pulp. The system included a three-basket IMPCO knotter followed by a three-stage conventional washer. Pulp at washer discharge consistency drops to a screw conveyor and is elevated to the top of an existing 26 ft. diam. by 40-ft. high storage tank having a capacity of 70 tons at 16%. The controls for this machine were completely replaced on a semigraphic panel common to both hardwood and softwood washers.

The screen room, formerly used for sulfite pulp, was rearranged for softwood kraft operation. This consisted of four Mark E. Cowan primary screens followed by No. 600 Bauer Centri-Cleaners. The system included 360 primaries, 60 secondaries, and 10 tertiaries. The original system included five gravity deckers which were replaced by conversion of an existing 9 ft.-6 in. by 16-ft. IMPCO washer thickener formerly used in the sulfite system. Stock from the high density storage is pumped to a buffer tank at approximately 4% consistency. From the buffer tank, stock is pumped to the headbox of the primary screen. The consistency is controlled by a DeZurik regulator and the flow by an automatic valve actuated from a magnetic meter. Three Cowan screens retained as primaries were equipped with 0.085 diam. perforated plates. Accepted stock from the primaries passes through 360 primary Centric-Cleaners to the washer thickener. After washing the stock is stored at 5% in a rebuilt 40-ton storage tank before the bleachery. Rejects from the primary screen are rescreened on one Cowan with 0.085-in. diam. perforations and the accepted stock delivered to the accepted flow from the primary screens. Rejects from the second screen pass over a Bird scalping screen and to two No. 623 Bauer Centri-Cleaners. The accepted stock from the Centri-Cleaners returns to the second screen feed and rejects from the scalping screen and Centri-Cleaners are sewered. Primary Centri-Cleaner rejects are pumped back in the conventional manner through 60 secondary screens and 10 tertiaries.

The location of the washer thickener was remote from the screen room operation. To assist the screen room operator in controlling this unit remote controls were provided and a closed circuit television was installed. This was the first installation of television in the mill and has proved successful.

Liquor Recovery

The old liquor recovery system was sized for manufacture of hardwood pulp only and was inadequate to handle the requirements imposed by the additional softwood tonnage. The equipment which was adequate or could be increased in capacity was retained, but a large percentage of the equipment had to be replaced.

The black liquor evaporators had been designed for 350 tons per day of equivalent pulp capacity. The unit was a Swenson sextuple effect evaporator with a surface condenser. The design was liberal and with relatively minor modification has satisfied the new requirements. The changes involved tube replacement with stainless steel, installation of an auxiliary barometric condenser, and improved venting and condensate removal. A substantial capacity gain was realized by an increase in liquor concentration due to brown stock washing improvements and the concentration that occurs at the Kamyr digester extractions system. It is interesting to note that the operation of the evaporator has improved under the heavier load. Careful control of the cleanliness of the machine is essential and periodic water boilouts are necessary.

The original recovery system consisted of one 200-ton Combustion Engineering unit and this was supplemented by the addition of a second unit of 300 tons per day equivalent pulp capacity. Fifty per cent black liquor is fed to the unit and concentrated to 75% in the Cascade evaporator before fed to the furnace. The unit is of conventional design and produces 137,000 lb. of steam at 700 p.s.i. and 750° temperature. Flue gases pass through a Koppers wet bottom

precipitator before being exhausted through an insulated type 316 SS clad stack. The vent from the dissolving tank passes through a J. O. Ross economizer. This has proved successful and is expected to return the investment in less than one year.

Dissolved smelt is returned to the existing Dorrco green liquor clarification system which was adequate for the new conditions. A completely new Dorrco slaking and causticizing system of conventional design was installed. This included a preslaker, Dorrco slaker and three 15-ft. diam. by 10-ft. high causticizers. A new 300-ton purchased lime silo serviced by a Fuller Airveyor filling system was installed. The original white liquor clarification and mud washing system was retained with minor modifications.

A new oil-fired Traylor lime kiln, 10 ft. diam. by 275 ft. long designed for 150 tons per day of lime, was installed. The kiln was equipped with a Bojner sector for an economizer and a trefoil refractory section. The controls for the kiln included automatic feed control from the inside temperature, automatic draft control and inlet air control from an oxygen analyzer. The latter has been a continuing source of maintenance. Auxiliaries for the kiln include a Bird centrifuge, Peabody scrubber, Traylor hot lime conveyor and a 100-ton hot lime storage. Currently the installation of a lump crusher on the kiln discharger is being considered.

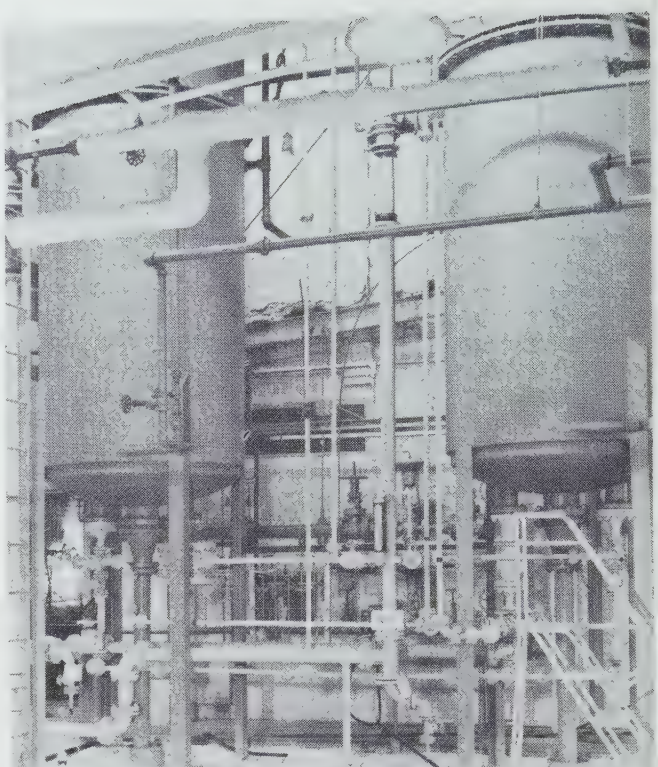
New storage tanks were provided for black, green, white, and weak liquor and for mud storage. In addition to normal storages a spare tank was installed sufficient in size to operate in any liquor service or to receive the charge from a clarifier during outage for cleaning or repairs.

Hardwood Bleaching

The existing hardwood bleachery was a modern IMPCO four-stage plant designed to bleach 300 tons of pulp to 80% brightness by chlorination, caustic extraction and two stages of hypochlorite. The equipment was physically adequate for the increased tonnage but to meet the new requirements for 86 to 88 brightness it was necessary to add a new chlorine dioxide stage in place of the second hypochlorite. Stock from the first hypo washer was diverted by a screw conveyor to a pin type steam mixer from which it drops to the feeder of a thick stock pump. Thirteen per cent stock is pumped through a chlorine dioxide mixer to the upflow tube of the dioxide tower. The down flow section of the tower is 20 ft. diam. by 80 ft. high and it has three side entering agitators in the bottom. After neutralization with caustic and dilution, the stock is pumped over a new 11 ft.-6 in. by 16-ft. 317 stainless steel washer. Washed stock is conveyed to the top of the existing second stage hypochlorite tower which was converted to a high density storage tank. From the bottom of this tank the stock is pumped at controlled consistency to a buffer tank and thence to the main bleach storage tanks serving the paper mill. The original controls for the bleachery were located on a full graphic panel and this was extended to include the new stage. Space was left in the area for a dioxide tower.

Softwood Bleaching

The existing softwood bleachery was inadequate for the new pulp and was completely rebuilt in the same area. The old equipment was removed and the building remodeled to accommodate a new four-stage IMPCO bleachery. To produce an ultimate brightness of 88 the plant was designed for chlorination, caustic extraction and two stages of dioxide with space provided for a second caustic stage. To satisfy immediate requirements of 86 brightness, the first dioxide stage was modified for use as a hypochlorite stage and is currently used in that service. Brown stock at controlled tonnage and consistency is pumped through two Wobble plate mixers in series and passes through a 90-min. 3% chlorination tower. Chlorine is added to the brown stock as either gas or water or in any combination of the two available.



Chlorine dioxide plant—chlorine dioxide reactors

Stock overflows the chlorination tower and flows by gravity to a 9 ft.-6 in. by 14-ft. rubber covered washer. Caustic is added to the doctor of the washer and the pulp drops through a pin type steam mixer to a thick stock transfer pump to the top of a 90-min. high density down flow tower. After dilution in the bottom the pulp is pumped to a 9 ft.-6 in. by 14-ft. steel caustic washer. Hypochlorite liquor is added as a shower on the doctor and the stock drops through a pin type mixer to a second thick stock pump. The stock is pumped through a dioxide mixer (inactive under present conditions) to the bottom of an upflow tube of upflow down flow tower having three-hour retention. The lining of this tower is set in a modified polyester cement to permit its use in either hypochlorite or dioxide service. After dilution in the bottom of the down flow section the stock is pumped over 9 ft.-6 in. by 14-ft. type 317 washer and drops through a pin type steam mixer to a third thick stock pump. Chlorine dioxide is added in a mixer at the bottom of the upflow tube of an upflow down flow tower having five-hour retention. Following dilution in the bottom of down flow section, the stock is pumped over a 9 ft.-6 in. by 14 ft. type 317 final washer. Stock discharged from this washer is diluted and dropped through a DeZurik pan type regulator and flows by gravity to a pump tank from which it is transferred at 4% to the main storage tanks serving the paper mill. The plant is controlled from a semigraphic panel located on the washer operating floor.

Pulp Storage and Distribution

Pulp from both bleacheries is pumped through bucket type meters to existing 4% slush storage tanks from which it is distributed to the beater room.

Chemical Manufacture

Existing equipment was available for the manufacture of chlorine, chlorine water, and sodium hypochlorite and these were used without change. To produce chlorine dioxide new facilities were installed. This was a $4^1/_2$-ton conventional Solvay plant supplemented by a smaller 2-ton gas absorption tower designed for use during the construction period when

Oxford Paper Company—standing: V. A. Carpano, manager, quality control; H. P. Waldenmyer, assistant mill manager-pulp; M. S. Anderson, supervisor groundwood and pulp bleaching; B. K. Mayer, assistant director of research. Seated: E. V. Ahara, chief engineer; C. L. Ferguson, mill manager; J. A. Rogers, assistant chief engineer; G. S. McKnight, director of research

only one of the two bleacheries would be in operation. New chemical receiving and storage facilities were provided for sodium chlorate, sulfuric acid and methanol. The chemicals are fed to the reactors by a variable speed Lap Pulsafeed gang pump. Air is supplied by a Roots-Connersville cycloidal blower. The reactors are lead-lined steel vessels and the primary absorber is a packed, brick-lined steel tower 2 ft.-4 in. diam. by 25 ft. high.

As the construction schedule dictated the start-up of the hardwood bleachery one year in advance of the softwood, the plant would be oversized during that period. To satisfy the condition of $1^1/_2$ to 2-ton operation, an auxiliary absorber was installed, built of resin impregnated fiberglass. To our knowledge, this was the first absorber of this construction and was completely satisfactory in operation. An existing chilling system previously used for sulfite acid manufacture was refurbished and reused. A spherical acid accumulator was relined for use on a chlorine dioxide storage tank. An attempt to reclaim spent chlorine dioxide liquor by absorbing it in black liquor was unsuccessful and major modifications to the system are currently in progress.

Hydrapulper

Pulp storage ahead of the paper mill is limited and rather than install large bleached storages at this time it was decided to store dried pulp as insurance against pulp mill outages. To disintegrate baled pulp an 18-ft. diam. 300-hp. Shartle hydrapulper was installed. This unit added to the pulping capacity of the beaters is sufficient to supply either softwood or hardwood to the paper mill. This machine in its intended function would be idle most of the time and the layout was arranged to permit its use as a part of a future broke repulping system.

Automatic Controls

Instrumentation and automatic process control was the subject of very detailed study. In the interest of operating efficiency and man-power economy all plants were automated as much as possible. The electrical and process control for all major plants were concentrated on central control panels at the operators station. Semigraphic panels were installed on the more complex operation and conventional panels on the similar installation. In all cases Panalarm systems were provided to sound on process variables or motor failures. Multitube bundles were used extensively made up of plastic tubing in the bleachery areas and copper tubing in other plants. To insure the best possible operation of pneumatic controls, a new 800-cu. ft. Joy air compressor equipped with regenerative desiccant air drier was installed for instrument air. This is tied in with the mill air system to spill surplus air or to bleed from the mill system in case of compressor failure. Minneapolis-Honeywell was the principal supplier of instrumentation with Foxboro, Leeds and Northrup, and Bailey supplying instrumentation for the Kamyr digester, lime kiln, and recovery units, respectively. A total of 150 ft. of panelboard and 19 miles of tubing used in the project give a visual picture of the extent to which the instrumentation was carried.

Electrical

Until 1953 all electric power used at the mill was 40 cycle. At that time the decision to convert to 60 cycle power was made and a conversion program has been in effect since. The major installations made in the pulping program provided an excellent opportunity to extend the 60 cycle system. Power was provided by five new 11,000–440 v. and two new 11,000–2200 v. load centers located throughout the plant. A total of 9500 new hp. was added and 1800 hp. converted from 40 cycle.

Protective Coatings and Painting

Severe corrosive conditions were anticipated in some areas and the subject of protective coatings was given serious consideration. The general painting specifications called for hot spray vinyl except in specific areas where temperature limited their use.

Buildings

In many cases, existing buildings were remodeled and reused. Often this was dictated by the location of associated processes and services and presented major construction problems. All new buildings were structural steel framing with H. H. Robertson Galbestos siding and precast concrete roof.

Research

The decision to convert to softwood kraft pulping at Rumford was preceded by studies of the potential growth of the company's markets and the ability of our local wood resources to meet future demands.

Intensive pulping and papermaking studies conclusively demonstrated the superiority of northeastern softwood kraft pulp for fine printing papers. Although the kraft pulp is significantly stronger than sulfite from the same wood it was found to be of equal slenderness and of equal or superior printing characteristics. Because of its greater strength, the softwood kraft permits an increase in the proportion of hardwood pulp in the furnishes. The unsurpassed qualities of the latter for printing papers has been well known. Engineering evaluations showed that conversion to all kraft pulping at Rumford entailed no capital penalties with respect to conversion of the sulfite system to a recoverable or cross-recoverable "base" such as magnesium or sodium. Conversely all kraft pulping at Rumford greatly simplified the chemical recovery system and eliminated all major sources of pollution in one integrated step.

The Research Department fully characterized all processing conditions for the various wood species involved, including pulping, bleaching, refining, chemical and heat recovery prior to detailed engineering. It then cooperated with the Engineering Department in the selection and evaluation of various equipment and process systems.

Engineering and Construction

The decision to proceed with the program was made late in the fall of 1958 and preliminary engineering was started in January of 1959. July 4, 1960, was established as the objective for starting up the hardwood side and July 1, 1961,

for the softwood plant. The company engineering staff and construction department, tailored to carry a normal capital program, were not sized to carry out the proposed work in the time available without assistance. It was decided that expanding the company's staff on a temporary basis was undesirable and the Rust Engineering Co. of Pittsburgh, Pa., was therefore engaged as engineer-contractors in certain areas. In dollar value the Rust Engineering Co. carried out approximately two-thirds of the engineering and one-third of the construction program. As far as possible the work was divided so that Rust worked in isolated new plants and Oxford in those areas closely associated with existing operations. Except for construction supplies on the Rust portion of the job, purchasing of materials was handled by the Oxford Purchasing Department—but expediting was done by the company doing the construction work.

The basic planning for the program was carried out in a committee with members representing the Oxford Research, Manufacturing and Engineering Departments and the Rust Engineering Co.

The problem of building a new mill inside an operating one presented major problems. Many of the installations were made in the center of manufacturing areas where continuity of existing operation was paramount. Others required rebuilding of old equipment to clear sites for new plants. To assist in relieving some of the space problem, the idle Island Division sulfite mill was started up and supplied the mill with softwood during the program. In spite of steps taken, construction congestion proved one of the more difficult construction problems.

To meet the target dates, detailed engineering and construction schedules were developed at the start of the program and strictly adhered to throughout the job. All start-up dates were met and all plants placed in operation almost to a day of the original schedule.

Major Equipment Suppliers

Chip screens, Orville Simpson
Log splitter, D. J. Murray Co.
Rechipper, D. J. Murray Co.
Pneumatic chip conveyor, Radar Pneumatic, Inc.
Chip silos, The Rust Co. (Slip Form); Neff & Fry (Conc. Stave)
Silo dischargers, Chain Belt Co.; Stephen-Adamson Co.
Mechanical chip conveyor, Chain Belt Co.; Stephen-Adamson Co.
Continuous digester, Kamyr, Inc.
  Accessories:
    Instruments & controls, The Foxboro Co.
    Process pumps, Swedish Delaval; Bingham Pump
    Digester, Chicago Bridge
    Prefabricated piping, Chas. F. Guyon Co.
    Piping supports, Basic Engineering Co.
    Heaters, Electric Steel Foundry Co.
    Steaming vessel, Mass. Engineering Co.
Blow tank, The Portland Co.
Brown stock washers & agitation, Improved Machinery Corp.
  Accessories:
    Instruments & controls, Minneapolis-Honeywell
    Tankage, Chicago Bridge & Iron
    Pumps, Warren Pump Co.
    Hood & ventilation, J. O. Ross Co.; Meade Pulp Sales Co.
Pulp screen, Trimbey Machine Co.
Bleach plant equipment, Improved Machinery Corp.
  Accessories:
    Instruments & controls, Minneapolis-Honeywell
    Towers, Chicago Bridge & Iron
    Linings, Stebbins Engr. & Mfg. Co.
    Pumps, Gould Pump Co.
Chlorine dioxide plant, Solvay Process
ClO_2 producers, Knapp Mills Co.
Absorption towers, Maurice A. Knight Co.; U. S. Stoneware Co.
Recovery unit, Combustion Engineering
  Accessories:
    Instruments & controls, Bailey Instrument Co.
    Smelt tank economizer, J. O. Ross
    Fans, American Blower Co.
    Pumps, Worthington
    S. S. clad stack, Portland Co.
Precipitator, Koppers Co.
Evaporator improvements, Swenson Evaporator Co.
Liquor storage tanks, Chicago Bridge & Iron
Slaking & causticizing, The Dorr Co.
Lime kiln, Traylor Eng. & Mfg. Co.
  Accessories:
    Instrumentation & controls, Leeds & Northrup
    Scrubber, Peabody Eng. Corp.
    Oil burning equipment, Coen Co.
    Fans, Buffalo Forge Co.
Hydrapulper, Shartle Bros. Mach. Co.
Electrical load centers, General Electric Co.
Motors, General Electric Co.
Motor controls, Westinghouse Co.
Gen. heating & ventilating, J. O. Ross Co.
Gen. prefabricated piping, C. F. Guyon Co.; Portland Copper & Tank Co.
Consistency regulator, DeZurik Regulator Co.
Stock control valves, DeZurik Regulator Co.
Misc. control valves, Minneapolis-Honeywell; Foxboro Co.
Heat exchangers, Delaval Co.; Condenser Service Co.; Rosenblad Co.; Artisan Metal Products Co.
Variable speed controls, American Blower Co.; Louis Allis Electric Co.
Instrument air compressor, Joy Manufacturing Co.
Centrifugal pumps, Ingersoll Rand Co.; Warren Pumps, Inc.; Labour Co., Inc.; Worthington Corp.; Gould Pump Co.

Packaging Corp. of America

At a recent ceremony in Hutchinson, Kan., attended by W. D. P. Carey, president of the Packaging Corp. of America, and other company officials, John G. Bolton, chairman of the Board of John W. Bolton & Sons, Inc., presented two P. C. of A. employees with checks for $200 and hand-engrossed, laminated wall plaques. Mrs. Joann Graham and Mrs. Margie Louise Cunningham were winners in the 14th annual Bolton Award essay contest which is cosponsored each year by John W. Bolton & Sons, Inc., and the Paper Industry Management Association.

St. Regis Paper Co.

Forestry Scholarship

St. Regis Paper Co. announces the award of its undergraduate scholarship in forestry to the northeastern United States for the academic year 1961–62 to **Thomas P. Leavitt,** a junior forestry student at the University of Massachusetts, Amherst, Mass.

Last year's recipient of the Northeastern scholarship award was **John A. Martin,** a forestry student at State University, College of Forestry, Syracuse University, Syracuse, N. Y. Mr. Martin completed the academic year 1960–1961 with a satisfactory scholastic record, which entitled him to another full year under the terms of the scholarship award. However, since he completed his course in three years, the second half or the 1960–61 award was made to his alternate, **Theodore J. Crovello,** a senior forestry student at the same institution.

St. Regis annually awards five undergraduate scholarships in forestry—three in the South and one each in the Northeast and Northwest.

The Northwest award was made to **Edmund R. Bodyfelt,** a sophomore at the College of Forestry, Oregon State University, and the Southern awards are to be announced in the near future.

Scott Paper Co.

Executive Offices and Research and Engineering Center

Scott Paper Co.'s new executive offices and research and engineering center, which was dedicated Sept. 19, 1961, is located on a 47-acre tract in Tinicum Township, adjacent to Philadelphia International Airport.

More than 800 men and women work in the new complex. The two buildings were designed with future expansions in mind and could, if necessary, be enlarged to accommodate a total of 1200 people.

The six-story office building contains 225,000 sq. ft. of floor space. The research and engineering center is a three-story structure having 156,000 sq. ft. A multimillion dolla

complex, the two buildings are connected by an enclosed corridor which is 380 ft. long. Welton Becket and Associates of Los Angeles planned, designed, and engineered the exterior of both buildings.

The proximity of the airport prompted special consideration during the planning and designing stages. An obvious requirement was to ensure proper insulation of the building against the noise of jet engines. Extensive research was done before a final window was adopted whereby advanced concepts of sound conditioning were utilized. Because the new buildings have a vast expanse of glass area, all windows on three sides have been fitted with double panes, having 5 in. of dead air space between them. The front of each building (both of which face away from the airport) also features double-pane windows, but with only 1 in. of dead air between them.

The site location also permitted maximum public exposure to the exteriors—not only from the busy Industrial Highway, but from low-flying airliners as well. For this reason, special attention was given to the ground forms with regard to their appearance from the air.

The exteriors of the buildings feature Scott-blue porcelain enamel spandrels alternating with bands of glass set between white columns. The architects employed moss-green glazed brick, the color and texture of which provide a transition between the natural landscaping and the building itself. Horizontal aluminum sunshades have been installed above most of the windows along the south, west and east sides to provide protection against extreme conditions of light and heat.

The steel framed, T-shaped executive office building features the latest demountable, radiant air conditioning system in the ceiling; structural steel deck flooring which provides underfloor electrical and telephone circuits; and movable steel walls.

Offices for Scott's top executives are located on the sixth floor which features two open courtyards. Also located on this floor are conference rooms and the executive dining room.

The task of designing the interiors of the office building was shared by Welton Becket, Rodgers Associates of New York, and A. Pomerantz & Company of Philadelphia. Initial planning and general design of the sixth floor executive offices was done by Rodgers; all other areas by Welton Becket. Pomerantz was responsible for the details of furnishing all areas of the building.

The main entrance to the office building features a unique tri-vaulted concrete portico leading to an enclosed hallway which opens into the lobby. The glass-enclosed lobby is divided into a reception area and a hospitality room by an off-white sculptured wood screen. The wall in the reception area is paneled with dark-brown, jewel tree wood and Scott-blue anodized aluminum inserts. The elevator core is faced with granite. The hospitality room provides visitors with several conveniences, including a desk, snack buffet, and check room. This room also features a unique wood mosaic mural by Tattersfield Associates of Philadelphia.

A modern, well-equipped medical center is located to the rear of the building on the ground floor.

On the third floor, the cafeteria affords a dramatic view of the airport. At the entrance of the dining area is a gaily colored lounge decorated with planters and featuring another Tattersfield mural depicting highlights of Scott's growth. An observation deck is located above the cafeteria.

The research and engineering center contains offices, laboratories, and pilot plant facilities. Offices and laboratories are arranged around three sides of the pilot plant area which is centrally located. All of the functional facilities of the research and engineering center were engineered by the Wigton Abbott Corp. of Plainsfield, N. J. This firm also planned and managed the construction of the building. The interior decorations were designed and executed by A. Pomerantz of Philadelphia.

Scott Paper Company's new executive offices and research and engineering center are located on a 47-acre tract in Delaware County adjacent to Philadelphia International Airport

Landscape design by Cornell, Bridgers and Troller of Los Angeles provides the entire site with a pleasant parklike setting. David Bachtle of Mendenhall, Pa., was the landscaping contractor.

History

In 1879, when the first incandescent lamp flickered in Edison's laboratory, two brothers, E. Irvin and Clarence W. Scott, pooled their rich talents and meager resources to form a paper jobbing firm that was to become one of the nation's leading paper companies. The beginning was modest: a push cart served as a delivery truck. Not only was the company small, but it also had to contend with a prudish public attitude toward mentioning one of the firm's principal products—bathroom tissue. This squeamishness extended even to the invention of synonyms for the product's name in order to avoid a term considered by some to be indelicate, yet this near-unmentionable product opened one of the liveliest chapters in the history of the American system of free enterprise.

In the 82 years since that humble founding of Scott Paper Co., the nation and the economy have grown far beyond the most rosy forecasts made in the latter part of the nineteenth century. Scott exemplifies that growth and illustrates the achievements of American industry that have made possible a standard of living higher than any in the world.

Seldom has a business advanced to leadership so rapidly. From a precarious venture that was started with $2300—most of it borrowed—Scott has grown to a corporation with nearly 11,000 employees, annual sales in 1960 of more than $313,000,000, and 16 manufacturing plants in the United States. It also has affiliates in eight foreign countries. The company is recognized as a leader in its field; it is respected for its high quality sanitary paper products, and it is now expanding into other fields, which will be described below.

Five basic products—bathroom tissue, paper towels, facial tissue, wax paper, and paper napkins—account for most of the company's sales. Yet when the company was founded, four of those five products were unknown, and the fifth, bathroom tissue, was considered a luxury.

The First Period: 1879–1909

The first or founding era of Scott Paper Co.—from 1879 to 1909—was the one during which the fundamental concepts underlying Scott's enviable record of success and growth were evolved.

For the first 20 years the Scott brothers dealt in coarse papers such as bags and wrapping paper. Then, with the

The flags of 19 nations in which Scott Paper Co. has foreign operations fly in front of the company's new three-story research and engineering center. The 130,000 sq. ft. building houses offices, laboratories and pilot plant facilities

development of modern plumbing, more and more attention was directed to a new product—bathroom tissue.

Initially, the Scott brothers manufactured the product for independent merchants according to their specifications and with their private labels on it. This method of operation was dictated in part by the fact that public prudery militated against mass promotion and advertising of bathroom tissue. Scott's private label business grew until at one time the company was producing more than 2000 different brands of the product.

Then, in 1896, Arthur Hoyt Scott, the only son of E. Irvin Scott, entered the business and revolutionized it: he urged that the multitude of brands be discontinued and that the company concentrate on a few Scott brands of high quality. That course, he felt, was the only way in which the company could really achieve its potential. At first he was opposed by some of his associates who felt that nearly two decades of success should not be shoved aside so quickly. But Arthur Scott was as tenacious as he was farsighted. He won.

Not only did he prevail on the subject of Scott brands, but he also evolved a set of company principles that have endured to the present. Arthur Scott's creed for the fledgling company was

> To concentrate on producing in volume a relatively limited number of products of high quality, to sell these products at the lowest possible prices, and to tell the public about them through extensive advertising.

Scott thus oriented itself toward the consumer—in Scott today, the quality control employees in the mills are called Consumer Representatives.

The Second Period: 1910–26

Between 1910 and 1926 lies Scott's second era when the company began to manufacture its own base paper stock to achieve a higher degree of quality control.

In 1910 an abandoned soap factory in Chester, Pa., was bought and two small paper machines were installed. Three years later, in 1913, Scott's sales exceeded $1,000,000. "ScotTissue" was also manufactured for the first time in 1913, and the production of private label brands was discontinued. Before the move to Chester, "Waldorf" bathroom tissue was being produced as were paper towels.

In 1918 Scott moved its converting operations from Philadelphia to Chester. And during that year the company spent $62,000 to tell customers about its products.

As the company grew, an effective sales force took on increasingly greater significance. Scott recognized that its success depended upon aggressive distribution methods as well as volume production of high quality consumer goods. In 1915, therefore, the selling operations were divided into two distinct departments—retail sales and industrial sales.

Simultaneously with this development, the company carried on an extensive expansion program. By 1926, eight paper machines were running seven days a week, 24 hr. a day.

The Third Period: 1927–44

Thomas B. McCabe, who had joined the business as a salesman 12 years before, was named president of the company in 1927, following the death of Arthur Scott. Under Mr. McCabe's direction, a new management was to blossom and many significant moves were forthcoming.

For more than twenty years the company's towel business had been confined largely to business and industrial plants. In 1931, the company decided to knock at the kitchen doors of the nation with ScotTowels. In 1940 a two-ply facial quality bathroom tissue, Soft-Weve, was put on the market and three years later the company's facial tissues, Scotties, were introduced.

Scott's first big move to assure a continuing pulp supply came in 1936 when it joined with The Mead Corp. in organizing the Brunswick Pulp & Paper Co. in Georgia.

As late as 1940, Scott's paper production operations were limited to the Chester plant; but, by 1944, additional mills in New York, Oregon, Washington, and Wisconsin were producing pulp or paper for Scott products.

By the end of the third era, then, Scott had grown from a single plant organization in Chester to a multiplant business with pulp and paper mills extending from coast to coast.

The Fourth Period: 1945–The Present

World War II ended in 1945, and that year Scott bought the company which produced Cut-Rite wax paper. This move brought the Hoboken, N. J., and Sandusky, Ohio, plants into the Scott production line.

Restrictions on the use of pulp and on the manufacture of paper products were lifted shortly after the war ended, and Scott was to enter a period of great expansion. Sales rose at an unprecedented rate. Equipment at all plants was modernized, and several new paper machines were installed.

In 1951, Falls Paper & Power Co., with its pulp and paper mill and converting plant at Oconto Falls, Wis., became a Scott subsidiary. This was followed later in the year by merging Soundview Pulp Co., owner of the largest bleached sulfite pulp mill in the world at Everett, Wash., into Scott. During the next year, construction of a new paper mill was begun at Everett. In that same year, Scott sponsored its first national television program.

In 1954, the Detroit Sulphite Pulp & Paper Co., with a mill in Detroit, Mich., was merged with Scott, as was the Hollingsworth & Whitney Co., which operated pulp and paper plants in Mobile, Ala., and Winslow and Madison, Me., and also owned extensive timberlands. (Scott recently sold the Madison mill.)

Scott has enjoyed a profitable export business for many years—it still does. But following World War II, restrictions on imports in many foreign countries, coupled with currency problems, prompted Scott's management to explore other means by which it could tap markets abroad more effectively. Scott decided to acquire foreign affiliates, which would have access to Scott's processes and skills in manufacturing and marketing. A fundamental of these acquisitions was that, wherever practical at least half of the equity of the foreign affiliates would be owned by the nationals of the country in which the business was to be located. This has been so in nearly all instances.

In 1954 Scott acquired its initial interest in Westminster Paper Co., Ltd. of British Columbia. The following year, Scott bought into British Columbia Forest Products Limited

and Cia. Industrial de San Cristobal, S.A., in Mexico. In 1956, Scott joined with the Bowater Paper Corp., Ltd. in organizing Bowater-Scott Corp., Ltd. of London.

Scott Overseas Corp. was incorporated in Panama in 1958 to function primarily as a wholly owned holding company for the foreign investments of the company.

Early in 1959, Scott de Columbia, S.A., was incorporated, and at about the same time Bowater-Scott Australia Pty., Ltd. came into being.

Late in 1960, Scott acquired an interest in Nova Scotia Pulp Ltd., which had been formed by Stora Kopparbergs Bergslags A/B, a Swedish company, to construct a pulp mill near Port Hawkesbury, N.S. The company has been licensed to use a revolutionary two-stage pulping and liquor recovery process developed by Stora which increases materially pulp yield compared with conventional processes. The mill is scheduled to come into operation late in 1961.

Shortly thereafter, Bowater-Scott Continental, S.A., was established in Brussels, Belgium, with ownership divided equally between Papeteries de Belgique and Bowater-Scott Corp., Ltd., Scott's English affiliate.

In April, 1960, another European affiliate of Bowater-Scott Corp., Ltd. of England was established in Turin, Italy. The new company is known as Burgo Bowater Scott, S.p.A., and is jointly owned by Cartiere Burgo, S.p.A., a leading Italian paper manufacturer, and Bowater-Scott.

In 1961, Scott's wholly owned subsidiary, Scott Overseas Corp., invested in a new Philippine paper corporation. The new corporation, called Eastern-Scott Paper Co., Inc., is owned 50% by Scott, with the remainder of the equity being held by Eastern Paper Mills Co., Ltd., a Philippine partnership. The new company is operating a mill in Quezon City, which is near Manila on the Island of Luzon.

In recent years, Scott research has turned out a number of new high quality products, including Scott Polyester Foam, Scott Cups, Dura-Weve and Confidets.

Scott's foam—its first nonpaper product—is a unique urethane product with what is known as an open cell structure; that is, it will trap solids, yet it has "breathability." Scott industrial foam is a superior material for air filtration. When thin sheets of Scott apparel foam are laminated to a fabric, shape holding qualities, and warmth are imparted with only a fractional addition in weight. A new plant in Eddystone, Pa., for the production of foam and molded containers was completed in 1961.

The company manufacturers both plastic and paper cups. These cups are sold widely in the vending machine market, and elsewhere.

Dura-Weve is Scott's reinforced paper. The company is still exploring the many possible uses for this paper, and is optimistic about the future of this product.

Public acceptance of Scott's sanitary napkins, called Confidets, has been highly favorable. To meet the demand for this item, Scott's wholly owned subsidiary, Falls Paper & Power Co., bought in 1960 the assets and business of Joa Co. in Florida, a producer of sanitary napkins.

In September, 1960, the company reorganized its top echelon in management. Two new executive vice-presidencies were created—one for marketing, filled by Harrison F. Dunning, the other for manufacturing, research and development, filled by Paul C. Baldwin. Both Messrs. Dunning and Baldwin had been vice-presidents and directors of the company. Those two, along with Andrew J. Schroder, 2nd, the administrative vice-president, constituted a newly created executive committee. Their average age is 52 years. Three months later, four other young Scott executives, averaging 45 years of age, were elected vice-presidents.

Early in 1961, the company started up a new high-speed, high-precision paper machine at its Mobile, Ala., mill. The cost of the paper machine and the substantial amount of allied equipment was more than $20,000,000; with annual papermaking capacity increased by 70,000 tons. While the machine can turn out several kinds of paper, some of which are produced elsewhere by Scott, it is the only Scott machine capable of making lightweight printing papers such as those that are used in the offset process. (Another expansion program for the tissue mill was completed in 1959.)

An expansion program is under way at Brunswick Pulp & Paper Co. (owned coequally by Scott and The Mead Corp.), which will double Brunswick's daily capacity for bleached sulfate pulp. The investment is upward of $35,000,000.

Late in the summer, the final moves to the new executive office building and research and engineering center, adjacent to the Philadelphia International Airport, brought all of Scott corporate staff under one roof, with researchers and engineers under another nearby.

Philippine Affiliate

Scott Paper Co. recently announced the incorporation of a Philippine affiliate, Eastern-Scott Paper Co., Inc., and the election of the new company's board of directors. This is Scott's first venture in the Philippine Islands. It follows the company's practice in its other foreign enterprises: ownership coequal with the nationals of the country where the business is located. (Scott has affiliates in Canada, Mexico, Columbia, the United Kingdom, Belgium, Italy, and Australia.) Eastern-Scott is owned 50% by Scott's wholly owned subsidiary, Scott Overseas Corp. The remainder of the equity is held by Eastern Paper Mills Co., Ltd., which is a Philippine partnership.

SIMPSON TIMBER CO.

Research Center

Simpson Timber Co. formally dedicated its new Research Center on August 16, in conjunction with the NAHB meetings in Seattle. Principal speaker during the ceremonies was E. J. Burke, Jr., president of the NAHB.

The Research Center, situated on a 10-acre wooded site in the new Overlake Industrial Park near Bellevue, Wash., 12 miles east of Seattle, is a progressive statement of the beauty, utility, and integrity of wood.

Created by Paul Hayden Kirk, F.A.I.A., distinguished Seattle architect, the building features such architectural components as glued laminated columns, folded roof plates, selected plywoods, and a diamond box beam roof construction, unique in industrial design.

The Research Center marks the second major building project completed this year by Simpson. An ultra-modern sawmill at Shelton, Wash., also featuring wood construction, was opened in February.

The Research Center building houses two principal activi-

Exterior view of Simpson Timber Co.'s new Research Center shows folded plates and diamond box beams used in roof construction

ties: the Research Division, under the direction of Robert J. Seidl, general manager of the Research and Chemicals Department, and the Engineering Division, under the Manufacturing Department, headed by Byrne C. Manson, director of engineering. Robert J. Seidl also is responsible for the general administration of the Center.

The laboratory is staffed and equipped to conduct experiments on a broad scope of forest products of present or potential interest. It will service Simpson operations throughout Washington, Oregon, and California and its location in Overlake Park places it within easy access of convenient transportation centers and the Simpson central offices in Seattle.

United Container Co.

E. H. Kardon, executive vice-president of United Container Co., announced that the name of Bicking Paper Mill, Downingtown, Pa., will be changed on Oct. 1, 1961, to the Downingtown plant of Daring Paper Mill. The Bicking Mill was purchased by United Container Co. in August, 1960, and has been operated as a division of that company.

The present Daring Paper Mill in Bridgeport, Pa., will continue to operate as the Bridgeport plant of Daring Paper Mill. This mill began operation in 1920, was purchased by the Kardon family in 1950, and operated independently until it became a division of United Container Co., 56th & Lancaster Ave., Philadelphia, Pa., in October, 1960.

Mr. Kardon stated that $350,000 has been spent at the Bicking mill to modify the equipment so that compatible grades of board could be produced at both of these mills. With a maximum trim of 73 in. at Bridgeport and 84 in. at Downingtown, the mills are currently producing all grades of tubing, folding, setup, and chipboard, as well as a complete line of liners including kraft filled, mottled "Dar-a-White," and specialties.

The two plants of Daring Paper Mill under the direction of **Frank J. Keating,** vice-president, Mill Operations, will continue to be operated as a division of United Container Co. and maintain separate offices in both Downingtown and Bridgeport, Pa.

Educational Institutions

Carnegie Institute of Technology

Thirteen special scholarships have been made available for study in Carnegie Institute of Technology's new department of graphic arts.

Ten of these scholarships are fully endowed and three are in the form of annual industry grants. The scholarships are in addition to those granted each year to Carnegie Tech graphic arts students from the general endowed scholarship fund of the institution and from the National Scholarship Trust Fund, Education Council of the Graphic Arts Industry.

The scholarships, based upon need, range in amount from $100 per year to full tuition, and will be awarded to students in either of the programs of professional study in the department—graphic arts management or graphic arts design. Preference will be given to qualified students in the management program. Previously the awards have been given to students in the School of Printing Management which the new department succeeds.

The ten endowed scholarships announced are: Book Manufacturer's Institute Scholarship; Graphic Arts Scholarship; W. F. Hall—Chicago Rotoprint Scholarship; Thomas P. Henry Scholarship; Herbick and Held Scholarship; George H. Judd Management Scholarship; Joseph T. Mackey Scholarship; Roy Trewin Porte Scholarship; William T. Rudge Scholarship; and United States News—Bureau of National Affairs Scholarship. Those awards based on annual grants by their sponsors are the Harris-Intertype Graphic Arts Management Scholarship, the Miller Printing Machinery Co. Management Scholarship, and the John McCormick Scholarship.

The department of graphic arts, beginning its second year of operation this fall, is the new center for teaching and research in all aspects of the graphic arts at Carnegie Tech. The program in graphic arts management has attracted international attention with its emphasis on scientific technology and on the emerging management sciences as a base for education of future executives in printing, publishing, packaging, advertising, and graphic arts supply industries. The professional design program also contains a number of significant innovations directed toward an expanded preparation of designers for careers in these industries.

Applications for these scholarships are now being accepted from high school seniors seeking admission in September, 1962. In a few cases, the scholarships are also available to college graduates enrolling in the two-year B.S. program in graphic arts management that will commence in 1962.

Institute of Paper Chemistry

The Institute of Paper Chemistry opened its doors for the new 1961–62 school year on September 18. Eighteen students have been accepted for the entering first-year class. Each of the students, except one who is not a United States citizen, will be at The Institute of Paper Chemistry on a full time scholarship granted by the Institute. The scholarship will include all tuition and fees, and a reasonable amount for living expense.

The new matriculants will raise the Institute student body to nearly eighty. Thirty-one of the students will have been admitted to doctoral candidacy and will be working on their doctoral dissertations as of the opening of the Fall quarter.

Trustees Elected

Elections for the board of trustees took place at the 32nd Annual Meeting of the Membership of The Institute of Paper Chemistry held Tuesday, September 12, at Appleton, Wis.

The elections filled six positions on the Board made vacant by normally expiring terms. Also filled was the position of senior trustee made vacant by the resignation of W. Irving Osborne, Jr., effective with the meeting.

Elected as senior trustees were D. K. Brown, founding trustee, Neenah, Wis.; George Olmsted, Jr., president of S. D. Warren Co., Boston, Mass.; and Ernst Mahler, Neenah, Wis., founding trustee and honorary chairman of the board of trustees. Elected a senior trustee for the unexpired term of Osborne was R. C. Doane, president, International Paper Co., New York, N. Y., formerly a term trustee.

Elected as term trustees were Maxwell D. Bardeen, president, Simpson Lee Paper Co., Vicksburg, Mich. Robert Faegre, president, Minnesota and Ontario Paper Co., Minneapolis, Minn.; and Howard Morgan, vice-president Weyerhaeuser Co., Tacoma, Wash., to the unexpired term of Mr. Doane.

Elected as nominee of Lawrence College, Appleton, Wis. for the position of *ex-officio* trustee was Karl Stansbury former chairman of the board of Thilmany Pulp and Paper Co., Kaukauna, Wis.

Mr. Osborne, in resigning as a senior trustee, indicated a majority of his activity is now devoted to a field outside the paper industry.

University of Maine

Frederic A. Soderberg, vice-president of the Huyck Corp., was elected president of the University of Maine Pulp and Paper Foundation at the annual meeting of that organization which was held recently at the University of Maine.

The Pulp and Paper Foundation is a nonprofit corporation the purpose of which is to encourage men to train for the pulp and paper industry and to give financial assistance to students

who enroll for pulp and paper courses at the University of Maine.

Foundation Committees

Frederic A. Soderberg, recently elected president of the University of Maine Pulp and Paper Foundation, has announced the election of chairmen of Foundation committees for 1961–62. Each of the chairmen will also serve as directors of the Foundation.

Paul C. Baldwin, executive vice-president of Scott Paper Co. of Chester, Pa., was named chairman of the scholarship committee. **William R. Adams** of New York City, president of St. Regis Paper Co., will be chairman of the nominating committee. **Harold Holden** of New York City, president of Gilman Paper Co., will serve another year as membership committee chairman. **Ralph A. Walkins** of East Walpole, Mass., president of Bird & Son, Inc., and treasurer of the Foundation, will be chairman of the finance committee. **Philip S. Bolton** of West Newton, Mass., director of research and development (retired) for the Robert Gair Division of Continental Can Co., is chairman of the curriculum committee; Hugh H. Morton of Cumberland Mills, production manager of S. D. Warren Co., is publicity committee chairman; and **Prof. Lyle C. Jenness,** head of the Chemical Engineering Department, is the research committee chairman.

The president of the Foundation is *ex-officio* chairman of the executive committee.

ST. JOHN'S UNIVERSITY

Packaging Institute Packaging Course

St. John's University, New York, in cooperation with the Packaging Institute, is planning a special seminar on packaging to be held during the fall term at St. John's Jamaica campus. The Seminar will be held on Wednesday evenings beginning Oct. 25, 1961, and terminating Dec. 6, 1961. Classes will be held in St. Albert's Hall at St. John's Jamaica Campus. Cost of the course is $30.

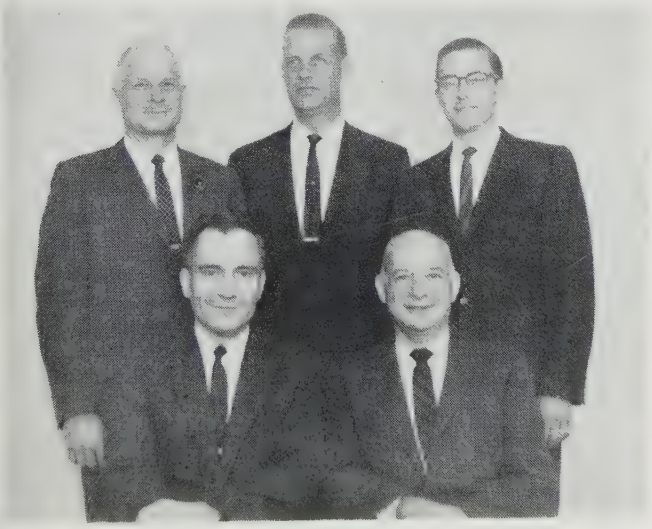
Interested parties should get in touch with James W. Field, Technical Director, The Packaging Institute, Inc., 342 Madison Ave., New York 17, N. Y.

Industry Suppliers

AER CORP.

William K. Metcalfe, president, recently announced the formation of a new corporation serving the pulp and paper industries. The new organization is AER Corp., Ramsey, N. J. The company will specialize in design and installation of air application equipment for any aspect of pulp or paper processing.

In formation of AER Corp., Mr. Metcalfe is joined by four associates: **Kenneth Jones,** vice-president and sales manager; **George Etzel,** secretary and director of purchases; **Robert Grott,** treasurer and director of engineering; and **Charles Guischard,** assistant secretary and regional sales manager.



AER Corp. officers—top: William K. Metcalfe, Kenneth Jones, Robert Grott. Bottom: Charles Guischard, George Etzel

ALLIS-CHALMERS MFG. CO.

New Pump Catalog

Allis-Chalmers complete expanded pump line is described in a new 1008-page Pic-A-Pump catalog now available from the company. Engineering data are conveniently arranged for selection of centrifugal, axial, or mixed flow pumps best suited to individual and specific applications. The information permits ready "engineering" of the pumping units and selection of the materials of construction needed.

The catalog includes parts listings and prices along with a 64-page yellow reference section carrying data relating to pumps, hydraulic design, and general tables and charts frequently required in the application of moving liquids.

The Pic-A-Pump catalog is available on request on company letterhead from Allis-Chalmers, Milwaukee 1, Wis.

APPLETON MILLS

An 80-year-old supplier of papermakers' felts has a new corporate name. Appleton Woolen Mills, organized in 1881 and operated under that name ever since, has become Appleton Mills. The change, voted by company stockholders in a special meeting, has been registered with Wisconsin's Secretary of State and has now gone into effect.

F. H. Orbison, president of Appleton Mills, explained the reasons for the change: "Appleton Mills is a streamlined improvement over our old name. Our business is manufacturing industrial fabrics. So, dropping the word 'woolen' much more accurately reflects its nature. But the change is simple enough so that the identity of our firm won't be lost.

"The new name will help us right now in our broad marketing program. It will also fit any new products we develop or new selling areas we go into. We're changing many things to make our company more competitive; the new name is just part of a much bigger effort.

"As is well known, wool is no longer the exclusive ingredient in manufacturing papermakers' felts. We now blend many synthetic fibers with wool for longer life and better performance. So there are technological reasons for the change, too," Mr. Orbison continued.

He explained that an additional benefit will be the elimination of the misconception that the company made yard goods. In 1902 Appleton Mills acquired the Reedsburg Mills, Reedsburg, Wis., which is disposed of in 1954. The company has not manufactured woolen yard goods since that time.

Approximately 170 men and women are employed by Appleton Mills in Appleton and in its eight sales offices throughout the country.

ARIZONA CHEMICAL CO.

Vincent V. Lindgren, technical director of American Cyanamid Co.'s Plastics and Resins Division, has been appointed manager of research and development at Arizona Chemical Co.

Arizona, a joint venture of Cyanamid and International Paper Co., produces tall oil and tall oil products at plants in Panama City, Fla., and Springhill, La.

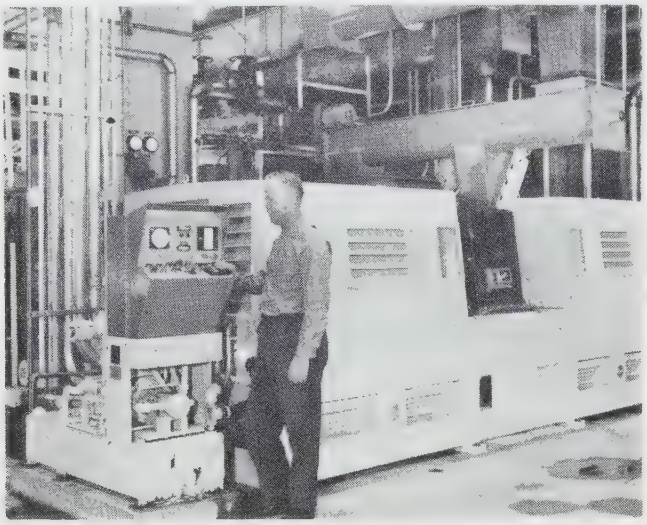
ATLAS CHEMICAL INDUSTRIES, INC.

A report on how three different polyester resins—bisphenol A, isophthalic, and general-purpose—and a room temperature and heat-cured epoxy withstood immersion for up to one year in various corrosive aqueous solutions at elevated tem-

peratures is now available from Atlas Chemical Industries, Inc. This information will be of interest to those in the chemical, paper, petroleum, metals, textile and other industrial fields, where these materials are used in fabricating chemical-resistant equipment. The 16-page bulletin includes curves showing strength retention of the various resins after immersion in a number of corrosive solutions for periods up to one year. In addition, tables are provided to indicate other specific effects of the corrosive media on the resins. The report, titled "A Continuation of the Comparative Study of the Corrosion Resistance of a Bisphenol A Polyester and Various Other Polyester and Epoxy Resins," can be obtained from Atlas Chemical Industries, Inc., Wilmington 99, Del. In Canada, write Atlas Powder Co., Canada, Ltd., Brantford, Ont.

BAUER BROS. CO.

The No. 480 double revolving disk refiner, designed and built by The Bauer Bros. Co., Springfield, Ohio, is the largest refiner in the world, and has been well proved in commercial



Two Bauer 480 integral motor-type refiners are now in operation in West Coast pulp mills

use. Two of the big machines are now being used in two different major newsprint mills on the West Coast. The first mill has been using its 480 since early June, 1960, while the second mill started its unit in July of this year.

The huge 480 refiner with its two 48 in. diam. disks is designed specifically for high energy input applications. These include groundwood from untreated chips, cold soda, and other chemi-mechanical pulping processes. However, design and engineering features of the field proved 480 are being incorporated in a complete new series of Bauer double revolving disk refiners. Models will be available in several sizes and several power ratings, to meet various production requirements.

BELOIT IRON WORKS

The Indian Productivity Team on paper visited the paper machinery manufacturing plants, Beloit Iron Works, Beloit, Wis. on Aug. 21, 1961. This group was sponsored by the National Productivity Council, Govt. Administration, Washington, D. C.

The leader of the team was Dr. J. C. Aggarwala, manager of Bengal Paper Mills, India. N. K. S. Iyenger, development officer, Govt. of India, Ministry of Commerce and Industry was the secretary.

A welcome speech was made by Harry C. Moore, president, Beloit Iron Works. R. L. Kutter, C. E. Macklem and J. E. Goodwillie, vice-presidents of Beloit Iron Works, also welcomed the guests.

The Indian Productivity Team at the Beloit Iron Works

On the team's side Dr. Aggarwala and N. K. S. Iyenger spoke giving the highlights of their trip and also present position and potentials of the pulp and paper industry in India. The team experienced great pleasure in visiting Beloit which is one of the largest paper machinery manufacturing firms in the world. While in Beloit the team also had the opportunity of visiting the new Research and Development Center of the Beloit Iron Works and also taking part in discussing the latest designs of paper machinery with Beloit and E. D. Jones experts. The team includes members of management, labor, sales, and other phases of the Indian Pulp and Paper Industry and is on a global tour learning methods, operations, and development in the field of pulp and papermaking in other advanced countries.

The team returned to India the middle of September after visiting bagasse pulp and paper mills in Venezuela and some other places in England, Finland, Sweden, etc., before returning to India.

BIRD MACHINE CO.

A new bulletin on the Bird Centriscreen has been issued describing the range of applications on both pulp and paper stocks and pictures and describing the four sizes of Centriscreens including the new Model 18 Centriscreen which has a capacity of up to 10,000 g.p.m.

Copies of this new bulletin may be obtained by writing to Bird Machine Co.'s home office at South Walpole, or by getting in touch with Bird Machine Application Engineering offices at Evanston, Ill.; Portland, Ore.; or Atlanta, Ga.

BLACK-CLAWSON CO.

Manufacturing and Sales Organization in Japan

The Black-Clawson Co., prominent manufacturer of pulp and paper mill equipment, has signed an agreement with Ishikawajima-Harima Heavy Industries, Ltd. (IHI), Tokyo, licensing IHI to manufacture in Japan the complete line of Black-Clawson machinery.

In announcing completion of the manufacturing agreement, Frank T. Peterson, president of Black-Clawson, also reported the formation of Black-Clawson (Japan), Ltd. as a service company in Japan to provide technical and sales liaison between IHI and Black-Clawson's five manufacturing divisions in the United States.

Public Relations Staff

The Black-Clawson Co. announces that Richard Davies recently joined the company's Public Relations staff. Located in the corporate office of Black-Clawson in New York, Mr. Davies is working under Public Relations Manager, Bruce Otis reporting news of activity in all Divisions of the

Richard Davies, The Black-Clawson Co.

George A. Hadlow, Jr., The Black-Clawson Co.

company and assisting generally in every phase of public relations, including media contacts.

Dilts Div.

The appointment of **George A. Hadlow, Jr.,** to the Technical Sales Service Department of the Dilts Div. of The Black-Clawson Co., Fulton, N. Y., has been announced.

JOHN W. BOLTON & SONS, INC.

New Dualator

The Emerson Manufacturing Co., Div. of John W. Bolton & Sons, Inc., has just introduced the Dualator, a machine that defibers pulps at least twice as fast—with only half the energy comsumption—as any other pulper available today. Designed and developed by the Pulp and Paper Research Centre, Inc., the Dualator has been field-proved during a year of continuous, full scale, mill operation.

The Dualator is based on an entirely new concept. Its design incorporates two, contra-rotating, coaxially mounted rotors (see Fig. 1) both of which are driven by a single motor operating through a specially designed right angle drive unit located beneath the cylindrically shaped tub. Streams of stock emanating from the inner rotor, moving counterclockwise, pass directly into the path of the vanes of the outer rotor, moving clockwise. This abrupt reversal in direction at the interfacial speed of 6000 f.p.m. produces tremendous hydraulic shear forces. Stock is literally ripped to shreads as it moves repeatedly across the narrow gap between the two rotors.

The flow pattern created by the interaction of the two rotors and the cylindrical shape of the tub is unique (see Fig. 2). Stock flows radially outward from the rotors to the side of the tub, then upward along the side wall, radially back to

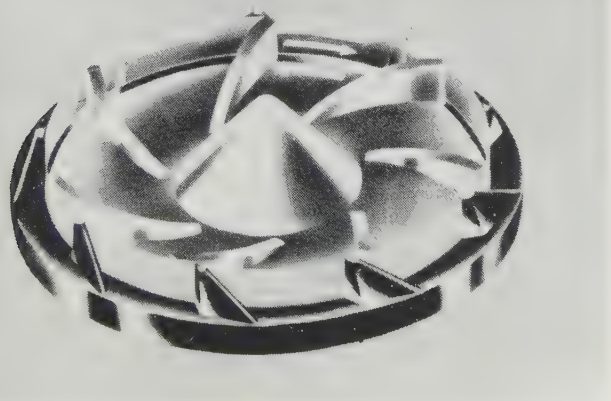


Fig. 1

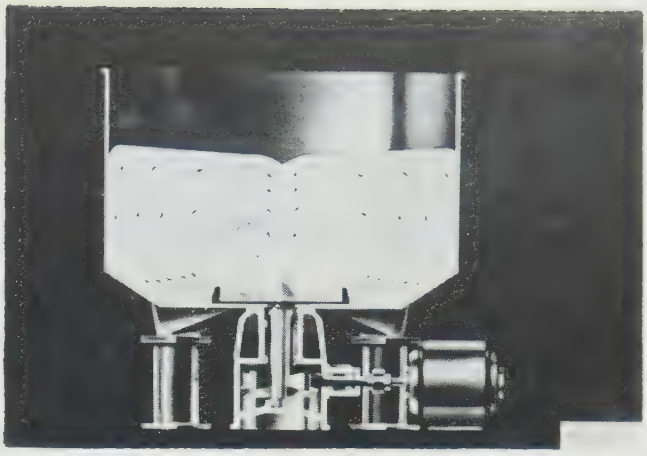


Fig. 2

the center and down again to the rotors. This circulation is not turbulent; on the contrary, it was designed to be relatively slow and positively controlled. This circulation pattern makes possible the remarkable energy efficiency achieved in the Dualator, since energy that would otherwise be dissipated in unnecessary circulation is effectively converted into useful defibering action.

The claim that the Dualator defibers twice as fast with half the energy consumption in comparison with conventional pulpers has been substantiated in hundreds of runs in a pilot plant unit on a wide variety of raw materials. And the results of many of these runs have been verified in a production-size unit installed in the Gilman, Vt., mill of the Gilman Paper Co.

Sales Executive Promotions

Lawrence R. Mitchell and **Henry S. Gilbert** have been promoted to product sales managers it was announced by F. Richard Convey, general sales manager of John W. Bolton & Sons, Inc., and The Emerson Manufacturing Co. Division. Mr. Mitchell assumes responsibility for the company's lines of pulpers and shower pipes and Mr. Gilbert's new activities concentrate on jordan and Cla in refiners, fillings, and actuators.

John E. Benedict has been promoted from senior sales engineer to manager of executive sales. In this capacity, he assumes responsibility for OEM, paper mill home office and engineering account contacts, and he will assume special assignments.

In other promotions announced, **Robert P. Calvert,** formerly senior sales engineer, was named Southern District sales manager, having supervision over direct selling activities in Virginia, North and South Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas.

Thomas J. Henry, formerly a sales engineer, has become Northeast District sales manager with responsibility for the New England states, New York, Pennsylvania, New Jersey, Maryland, Delaware, and West Virginia.

Robert W. Hohman, a senior sales engineer since 1959, was made Midwest District sales manager with responsibility for direct sales in Ohio, Kentucky, Indiana, Illinois, Missouri, Kansas, Colorado, Iowa, Minnesota, Wisconsin, and Michigan.

CLINTON CORN PROCESSING CO.

Appointment of **John Bierie** to the position of assistant western division sales manager, with headquarters at San Francisco, has been announced by A. C. Junge, vice-president—sales, Clinton Corn Processing Co., Clinton, Iowa.

Mr. Bierie will be succeeded as district manager at Seattle by **O. K. Gordon.**

The appointment of **Robert H. Boegel** as New York district manager has also been announced.

Corn Products Sales Co.

Starch Cooker

A new type continuous starch cooker which will operate either full time, or respond automatically to process demands, has been developed by the Industrial Division, Corn Products Sales Co., 10 E. 56th St., New York 22, N. Y. It is the first automatic starch cooker which allows the operator to select continuous or intermittent operation by simply pressing a button. It is capable of either partial or complete pasting (complete disruption) of starch granules.

The cooker can be designed to deliver any reasonable quantity of paste per minute. High- and low-level indicators control cooker operation and insure a continuous supply of fresh starch gel.

Tied in with a starch bulk handling and slurry preparation system, the unit can completely automate starch handling—from unloading to point of use. Even when drawing slurry from a day tank fed by bagged starch the cooker takes the guesswork out of paste preparation, eliminates need for large capacity cooking and storage equipment and does away with sewering or prolonged paste holdover.

The compact unit occupies only 6 sq. ft. of floor space. Price for the unit ranges from $300 to $3000 depending on the need for accessory items such as modifying ingredient tanks, additional pumps, extra heaters, etc. Existing plant equipment which can be utilized will also be a factor in the cooker price.

It can be installed at any point in the plant and can easily be sectionalized, if necessary. Installation can usually be completed within one 8-hr. shift and will be supervised by Corn Products engineers.

Crane Packing Co.

Guide to Sealing

A new sealing guide has been especially developed to provide recommendations and information on sealing applications in all phases of pulp and paper mill operations. Contents—covering mechanical packings, shaft seals, pipe joint, and gasket compounds—are conveniently bound in sectional form for easy use and filing. A reference guide chart covering all types of equipment in which seals and packings are used supplies foolproof recommendations which will result in better performance, longer service life and reduced maintenance. Subsequent sections give illustrated, technical information on everything listed in the chart.

For a copy of the sealing guide write Crane Packing Co., Dept. TI-6, 6400 Oakton St., Morton Grove, Ill. In Canada: Crane Packing Co., Ltd., Dept. TI-6, Box 134, Station C, Hamilton, Ont.

DeZurik Corp.

Public-Seated Gate Valve

The DeZurik Corp., Sartell, Minn., is currently producing a metal-seated bonnetless knife gate valve that has been widely accepted in a variety of industries. Several years ago, DeZurik made the decision to extend the scope of their gate valve line to include a rubber-seated gate valve for driptight shutoff on liquids, slurries, and gases.

The rubber-seated gate is the answer to many valving problems in the paper industry. The valve features simplicity of design, ease of maintenance, and where corrosive and abrasive services require high alloys, their use is limited to the wetted parts of the valve only. The driptight shutoff feature of the valve was made possible by our designing of the ring seal seat. A variety of resilient compounds may be used in the DeZurik ring seal seat depending on the service being handled.

Pipeline Consistency Regulator

A new 4-page, 2-color Bulletin 400 is now available describing and illustrating DeZurik's new compact pipeline consistency regulator. The new pipeline regulator provides a highly successful solution to the problem of producing stock of a uniform consistency in a closed system, and is widely used on pressure refining systems, ahead of stock meters, and in stock transmission systems. For complete information and specifications write to the DeZurik Corp., Sartell, Minn. In Canada, DeZurik of Canada, Ltd., Galt, Ont., Canada.

Dorr-Oliver, Inc.

Brazil

In order to provide expanded services to its many customers in Brazil, a new subsidiary corporation has been formed by Dorr-Oliver, Inc., Stamford, Conn. Known officially as Sociedade Tecnica, Industrial e Comercial Dorr-Oliver (Brazil), Ltda., the new company has its headquarters at Rua 15 de Novembro 164, 3° andar, Sao Paulo. The new firm will conduct sales, engineering, and procurement activities relating to installations of Dorr-Oliver equipment and processes in the fast-growing industries in all sections of Brazil. Local manufacturing of D-O equipment will make use of independent Brazilian shop facilities.

Activated Sludge Process

A new 4-page brochure, Bulletin No. 7320, describing four recent equipment and flowsheet developments for the activated sludge waste treatment process, has been issued by Dorr-Oliver Inc., Stamford, Conn.

The four Dorr-Oliver developments described in this bulletin are the D-O INKA Aeration System, the D-O Aerator, the RSR Clarifier, and the SpiroVortex System including the Superate Filter. The D-O INKA Aeration System provides highly economical diffused aeration at shallow depth with low first cost and operating requirements. The D-O Aerator provides highest oxygen absorption capacity for activated sludge process demands. The RSR Clarifier provides rapid sludge removal to minimize sludge detention in final clarifiers. The SpiroVortex System combines the simplicity of Biofiltration with activated sludge treatment efficiency.

Appointment

Harold A. Monsor, for the past two years production manager at Dorr-Oliver's Hazelton, Pa., plant, has assumed new duties as director of production—Stamford. In his new post at the company's international headquarters in Stamford, Conn., he will have administrative responsibility for production and purchasing operations at Stamford, and for the company's manufacturing operations at Englewood, Colo.

He studied industrial and mechanical engineering at the University of California in Berkeley.

He is the father of three boys and three girls.

Mr. Monsor and his family were residents of Westport from 1957 to 1959. They will make their new home on Poplar Road, in Ridgefield. Conn.

Dow Chemical Co.

A regulation recently issued by the Food and Drug Administration on the status of certain components in Dow styrene-butadiene latexes clears two latexes, Dow Latex 630 and X-3352, for long-term use in food contact application. The regulation, published in the September 16 Federal Register, is the result of a petition submitted by Dow. Prior to its issuance, converters, and packagers could rely only on the time extension clause in the 1958 Food Additives Amendment.

DU PONT

P. Park White, dyes and intermediates salesman for du Pont in the Southern district, has been transferred to the staff of the Technical Laboratory at Deepwater Point, N. J., the company's Dyes and Chemicals Division has announced.

Named to succeed him is **Boyd F. Vaughan** who has had 15 years' experience with the company's Dyes and Chemicals Division as a salesman in the Chicago district. Mr. Vaughan, who will make his headquarters in Mobile, will call on paper mills in Alabama, Arkansas, Florida, Louisiana, Mississippi, and eastern Texas.

FRANK W. EGAN & CO.

15th Anniversary

Plans are being completed for a conducted tour on October 20 of Frank W. Egan & Co.'s recently expanded plant facilities. The event, commemorating the firm's 15th anniversary, will be attended by members of local, business, and trade press, as well as area industrial, civic, and banking leaders.

Appointment

William S. Bunte has joined the staff of Frank W. Egan & Co., Somerville, N. J., as a sales engineer. Mr. Bunte, a graduate engineer of Rice Institute, is former manager of Riegel Paper Corp.'s Paterson (N. J.) plant. He will specialize in the sale of extrusion coating equipment with the Egan firm.

William S. Bunte, Frank W. Egan & Co.

FELKER BROS. MFG. CO.

New Lite Wate flanges are now manufactured by Felker Bros. Manufacturing Co., Marshfield, Wis., in two types. One is the lap joint, or back-up type and the other one is the slip on, or weld on type flange.

Lite Wate flanges are made of either mild steel or stainless steel. Complete specifications, sizes, etc., are contained in Bulletin No. 46-47.

FISCHER & PORTER CO.

Stock Flow Control System

Fischer & Porter Co., 999 Jacksonville Rd., Warminster, Pa., has published a new 4-page Application Bulletin 90–26–14 that outlines a stock flow control system comprised of F&P instrumentation. The bulletin lists and describes the elements of the system and cites a few of the features, such as alarm contacts to indicate pump failures and stock shortages, that can be added to the basic system.

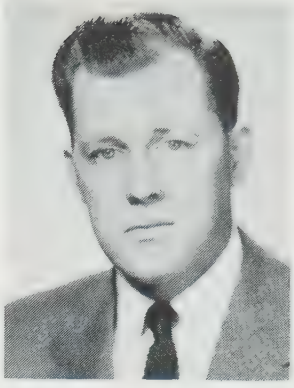
Instrumentation for the Chemical Process Industries

A new condensed Catalog 310, describing various measurement instruments and complete instrumentation systems for flow, level, pressure, temperature, and other process variables is also available from Fischer & Porter Co. The illustrated 8-page publication describes the company's capabilities in the field of instrumentation for the chemical process industries and explains some of the services—panel engineering, user education, etc.—that are a part of such capabilities.

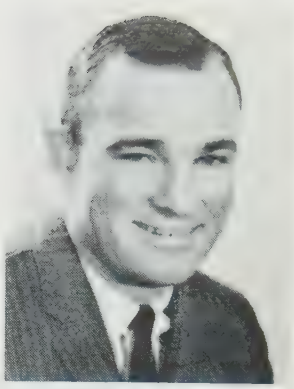
GENERAL ANILINE & FILM CORP.

Antara Chemicals Div.

E. S. Underwood has been named to the position of



E. S. Underwood, Antara Chemicals, GAF



W. C. Calvert, Antara Chemicals, GAF

product manager—surfactants, and **W. C. Calvert, Jr.,** has been appointed product manager—heavy chemicals at Antara Chemicals, a Division of General Aniline & Film Corp., New York.

GLIDDEN CO.

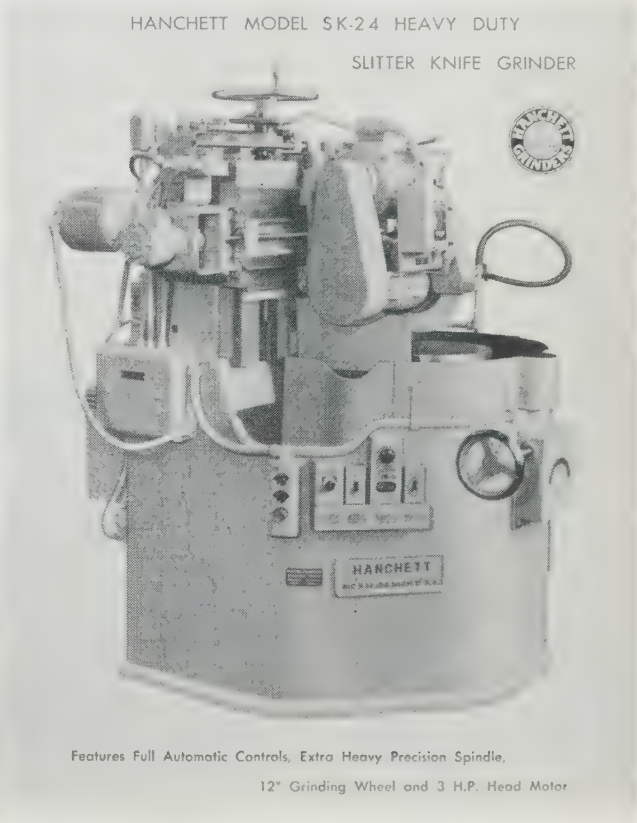
Appointment of **Louis J. DeChellis** as a sales representative in the Texas territory for the Pigments and Color Department of The Glidden Co.'s Chemicals Group. In this capacity with Glidden, Mr. DeChellis will be responsible for developing sales of Glidden titanium dioxide, lithopone, color ingredients, and copper pigments in the entire state of Texas.

HANCHETT MFG. CO.

Slitter Knife Grinder

To augment the present line of SK-24 slitter knife grinders, Hanchett has developed a new machine for the user of such knives who requires extra high production while maintaining accuracy and perfect edge finish.

Known as the SK-24 High Power, this new grinder utilizes a 12-in. wheel mounted on a precision Pope spindle. The


HANCHETT MODEL SK-24 HEAVY DUTY
SLITTER KNIFE GRINDER
HANCHETT
Features Full Automatic Controls, Extra Heavy Precision Spindle,
12" Grinding Wheel and 3 H.P. Head Motor

motor is fully balanced, 3 hp. and all supporting members are made heavier to give adequate support to the larger grinding head assembly. Down feed, cross feed, and oscillation of the grinding head are each equipped with motor drive and controls are fully automatic.

For full information, write Hanchett Manufacturing Co., Big Rapids, Mich.

HEWITT-ROBINS

Conveyor System Engineering

Horsepower requirements for belt conveyors have been a controversial subject among bulk materials handling engineers for the past 50 years, because the many variables had never been measured completely to compose an accurate formula.

As the result of a grant from Hewitt-Robins, Pennsylvania State University engineers conducted an investigation to develop techniques to analyze separately the power consumed by troughing idlers, return idlers, return strand of belting, and the carrying belt (both loaded and unloaded).

This coordinated program has resulted in a spectacular advance in conveyor system knowledge that will benefit the industry in general for many years. The formula which was developed as a result of the 2-year study has been incorporated with other comprehensive data in a brand-new booklet (Bulletin 175) available from Hewitt-Robins, Sept. CBE, Stamford, Conn.

Complete statistical data and tables for calculating, engineering, and selection of conveyor belting are also included in the new publication.

HEYDEN NEWPORT CHEMICAL CORP.

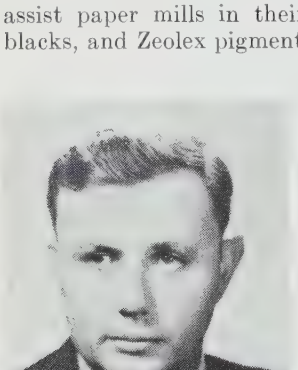
Heyden Chemical Division

Arthur Minich has been appointed president of the Heyden Chemical Division of Heyden Newport Chemical Corp. Mr. Minich is succeeding R. M. Aude who died on August 20.

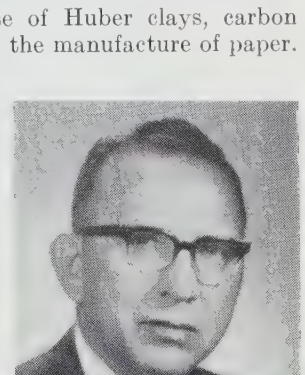
Gordon W. Pixler has been appointed to expand the Newport Industries Divisions's technical service for paper mills in Texas, Arkansas, Mississippi, and Louisiana, it was announced recently by A. G. Dreis, product sales manager, Paper Chemicals, for the Newport Industries Division of Heyden Newport Chemical Corp. Mr. Pixler will be based in Alexandria, La., and his mill activities will be supported by Newport's Pensacola Paper Chemicals Laboratory.

J. M. HUBER CORP.

Robert W. Shaw has joined the Technical Service Group of J. M. Huber Corp.'s Industrial Products Department, located in Huber, Ga. Mr. Shaw will be available to assist paper mills in their use of Huber clays, carbon blacks, and Zeolex pigments in the manufacture of paper.



Robert W. Shaw, J. M. Huber Corp.



Henry E. Wilt, Improved Machinery, Inc.

IMPROVED MACHINERY, INC.

Improved Machinery, Inc., Nashua, N. H., announces the appointment of **Henry E. Wilt** as sales representative in Michigan, Ohio, Indiana, and Illinois. Mr. Wilt is a graduate civil engineer and was formerly an assistant pulp mill superintendent at West Virginia Pulp and Paper Co., Luke, Md. His home is in Kalamazoo.

I-T-E CIRCUIT BREAKER CO.

William G. Long has been named manager of I-T-E Circuit Breaker Co.'s Transformer and Rectifier division. The new manager, who has been assistant manager since 1959, will be responsible for the overall operation of the division—located in Philadelphia—which produces semiconductor rectifiers and power transformers, as well as packaged unit substations.

JUSTIN ENTERPRISES, INC.

The development of a unique low-cost, lightweight spherical tank fabricated from a specialty glass-reinforced polyester has been announced by Justin Enterprises, Inc., 3755 Edwards Road, Cincinnati 9, Ohio. The tank, called the Chemisphere, is recommended as a processing or storage unit for such industries as paper, chemical, textile, metals, petroleum, agricultural, and others, where corrosive conditions necessitate a structure with high chemical resistance. Weight of the Chemisphere is approximately one-seventh that of a comparable stainless steel unit.

KROFTA ENGINEERING CORP.

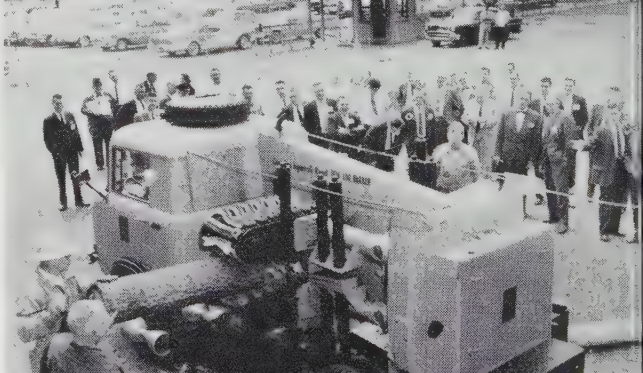
Krofta Engineering Corp. has announced the signing of an agreement with the James Hunter Machine Co., North Adams, Mass., to manufacture the Krofta line of flotation savealls. The Hunter Machine Co. services its customers through its three plants in North Adams, Maldin, S. C., and Los Angeles, Calif.

SAMUEL M. LANGSTON CO.

New Plant of Greenwood (Netherlands)

The official opening of the new plant of Greenwood (Netherlands) N. V. at Groningen, Holland, took place Aug. 14, 1961 with ceremonies attended by officials from The Hauge, the city, the area, the American embassy, suppliers, and the company.

Approximately 120 guests heard greetings from Groninger Burgomaster J. Tuin and Greenwood (Netherlands) Director of Operations James Florent. President Bryant W. Langston of Samuel M. Langston Co., Camden, N. J., expressed the company's thanks to all who assisted in establishment of the new plant and the firm's pleasure in its location at Groninger.



Mobile log barker manufactured by Canadian Ingersoll Rand

Front view of new plant of Greenwood (Netherlands) N.V., Groningen, Holland, which was opened officially Aug. 14, 1961. The plant will produce printer-slotters

Greenwood (Netherlands), a subsidiary of Langston Overseas, A.G., Zug, Switzerland, is producing printer-slotters for the corrugated container industry.

The new installation is the first U. S. industrial plant to be established in Groningen province under a 1959 law assisting companies to establish plants in centers designated by the central government for industrial development.

Sale of the Groningen-built machines is being handled by Langston Overseas. Alfred K. Schelling is director of Langston Overseas and is situated at Gubelstrasse 17, P.O. Box 217, Zug. He is assisted by Dante Capoccia, Via Ressi, 7/A, Milan, Italy. Cable address for Langston Overseas is Langston Zug; telephone 4.91.12. Cable for Greenwood (Netherlands) is Langston Groningen; telephone 37080.

The new plant is a one-story brick and concrete building with 18,000 sq. ft. of floor space. Prior to start of operations in the new building, Greenwood (Netherlands) built and shipped three printer-slotters in temporarily rented quarters in Groningen.

The official opening ceremonies were followed later in the day by an open house for employees and their families. Pins in the form of the Langston company trademark were distributed to employees.

LUNKENHEIMER CO.

The new Lunkenheimer type 316 stainless steel ball valve, designed for corrosive fluids, gases, and general corrosive services; is described and detailed in a new full-color catalog sheet prepared by the Lunkenheimer Co. of Cincinnati 14, Ohio. Circular 612 describes the operation of the valve, shows cutaway views, gives pressure ratings, covers specific design and dimensions, reports on applications and advantages.

MIDLAND-ROSS CORP.

The election of **Harry J. Bolwell** as vice-president of Midland-Ross Corp. and general manager of the company's Surface Combustion Division was announced recently by Wade N. Harris, president. Mr. Bolwell previously was general manager of the Chattanooga Division of Combustion Engineering, Inc.

J. O. Ross Engineering Celebrates 40th Year

The J. O. Ross Engineering Div. of the Midland-Ross Corp., New York, N. Y., entered its 40th year of operation this year.

The company, organized as J. O. Ross Engineering Corp., opened its doors in 1921 with seven employees, headed by John O. Ross. The new organization specialized in ventilating systems for the paper industry and drying systems for converting plants in the East. Today the company has two plants in New Brunswick, N. J., and one in Los Angeles, and has sales offices in New York, Chicago, Boston, Atlanta, Detroit, Seattle, Los Angeles, and Mobile.

The company found an early and continued acceptance of its services and is today the leading supplier of ventilating and drying systems to the paper industry. It provides millions of dollars worth of equipment annually to this field alone for such purposes as air make-up, machine room ventilation, paper machine hoods, felt drying, wet and dry-end exhaust, calender cooling, motor cooling, trim conveying, comfort cooling, laboratory temperature and humidity control, finishing room conditioning, stock preparation ventilation, high velocity drying, and other paper, pulp, and converting mill air systems.

In servicing paper mills, the company early became associated with John Waldron Co., New Brunswick, N. J., manufacturer of paper processing equipment and web and roll-handling equipment, and over the years Ross Engineering acquired the majority of the stock of this company. The Waldron association proved to be a valuable one, not only in the paper field out in the plastics, textile, and metal fields as well. The products and services of the two companies often complement one another and frequently enable customers to purchase facilities from one responsible source rather than from several.

Another Ross affiliate that augments its service to the paper field is Ross Midwest Fulton located in Dayton, Ohio. This organization designs and manufactures drier drainage systems for paper machines and was bought by Ross in 1954.

J. O. Ross Engineering merged with the Midland Steel Products Co. in 1957, and since that time has operated as a division of the Midland-Ross Corp., now one of the 500 largest firms in the nation.

To supplement its engineering services, Ross Engineering maintains laboratory facilities at one of its New Brunswick plants. Here, customer drying problems can be studied and the effects of cross, downward, upward and parallel air flow, and air impingement can be visually observed and the effects of various air flow conditions at various temperatures can be measured and scientifically evaluated.

One of the more recent developments to come out of the Ross laboratory is high velocity drying. High velocity drying directs heated air at high velocities against traveling webs and speeds drying time, increases production and lowers costs. It is not only being applied to paper processing but is also used in the new Ross-Waldron metal strip coating process and in such applications as drying printed grains and lacquer finishes applied to plywood.

Many Ross pioneers are still with the company. This is evident by the fact that at the present time there are 62 members that have been with the company for 25 or more years.

MINERALS & CHEMICALS PHILIPP CORP.

Minerals & Chemicals Philipp Corporation of Menlo Park, N. J., has recently announced that the western Europe technical sales and service activities of its Paper Sales Department will be handled by **Heinz P. Petereit,** who has long been connected with the practical and development of paper and paper coating in Germany. Dr. Petereit is a representative of Pluess-Staufer (North American) Inc.

MOORE & WHITE CO.

Shaftless Backstand

A new shaftless backstand unit introduced by The Moore & White Co., 330 E. Hunting Park Ave., Philadelphia 24, Pa., is designed to operate with a wide variety of finishing and converting equipment. The elimination of through shafts allows this unit to be loaded without the use of overhead cranes, lift trucks, or other material handling equipment. Usually one man can easily handle the largest roll, rolling it

into position between the two end stands. A hydraulic lift built in at floor level raises the roll to proper height. The two motorized side frames are then run in allowing the pneumatic chucks to engage the core.

Backstand units are provided with both cross and endwise adjustment for alignment of web. Paper tension can be controlled by the pneumatic braking system which also serves to completely stop the roll in the event of a paper break or shutdown of associated equipment.

Available singly or in matched sets these backstands provide highly flexible operation for a wide variety of winding, cutting, slitting, laminating, and treating equipment.

MORNINGSTAR-PAISLEY, INC.

Oxidized Potato Starch

An improved line of oxidized potato starches called Arogums are produced by Morningstar-Paisley, Inc., 630 W. 51st St., New York, N. Y., in the company's modern starch plant at Carys Mills near Houlton, Me. The typical "long" texture of potato starch imparts to Arogums that improved film structure which is desirable in surface sizing and coating operations. Arogums come in several viscosities to meet the varied requirements of tub, calender, and size press operations.

NICHOLS ENGINEERING & RESEARCH CORP.

The Board of Directors of Nichols Engineering & Research Corp., New York, engineers and suppliers of processing equipment to industry and to the sanitary engineering field, have elected **Douglas R. Nichols, Jr.,** executive vice-president of the firm.

PENN-OLIN CHEMICAL CO.

Penn-Olin Chemical Co. new sodium chlorate plant at Calvert City, Ky., commenced operation on schedule, September 1. The 26,000-ton per year capacity plant under construction since October, 1960, is the newest entry into the growing sodium chlorate market. Sodium chlorate has grown in use in recent years as the source of a basic bleaching chemical, chlorine dioxide, used in the pulp and paper industry. In addition, sodium chlorate is the raw material for producing ammonium perchlorate, an oxidizer for solid propellent systems in missiles and space vehicles.

Penn-Olin Chemical Co. was formed early in 1960 by Pennsalt Chemicals Corp. and the Olin Mathieson Chemical Corp. The multimillion dollar electrochemical unit comprises the latest Pennsalt cell design, with fully automated control and production systems. Olin, through its regular sales offices and marketing organization, is handling the sales of sodium chlorate from this new facility which Pennsalt is operating.

PENNSYLVANIA INDUSTRIAL CHEMICAL CORP.

Albert M. Berseth of the Pennsylvania Industrial Chemical Corp. has been named new head of process, development, and maintenance to replace **Ronald Neubert** who has been promoted to general production manager of this company. **R. W. Ostermayer, Jr.,** has been named executive vice-president of Pennsylvania Industrial Chemical Corp., large manufacturer of synthetic petroleum and coal tar resins in Clairton and Chester, Pa. Mr. Ostermayer is a graduate chemical engineer from Pennsylvania State, and has been in charge of plant management and production for his company for the past fourteen years.

PFAUDLER-PERMUTIT, INC.

Julius Yetka, Permutit Industrial Division general manager, announced the formation of a new activity, Divisional Product Planning and Development. The new group will be headed by **Stanley Lenox,** who was formerly in charge of the division's engineering functions. Divi-

Durando Miller, Pfaudler-Permutit, Inc.

Donald C. Senges, Pfaudler-Permutit, Inc.

sional Product Planning and Development will be responsible for new product development, improvement of present products, and the investigation of new applications for Permutit equipment.

At the same time, Mr. Yetka announced that **Durando Miller,** formerly Divisional Technical Manager, will henceforth head both the technical and engineering functions with **Eugene Driscoll** as assistant manager of the Technical Department.

On the marketing side, the appointment of **Donald C. Senges** to the new post of manager of special markets was announced by J. I. Munson, general sales manager of the Permutit Industrial Division. The Special Markets group will assume responsibility for the sale of Permutit products to the municipal and waste treatment markets as well as the promotion of special applications of ion exchange processes to industry. Permutit's new marketing group is also undertaking establishment of a nationwide dealer organization.

The Permutit Co. has also announced the establishment of a new industrial sales office at 3603 Lemmon Ave., Dallas, Tex., under the direction of **Austin F. McCormack.**

PHILADELPHIA QUARTZ CO.

William Stericker, formerly development chemist and presently consultant with Philadelphia Quartz Co., manufacturers of soluble silicates, was presented a distinguished service award by the American Chemical Society, Division of Water and Waste Chemistry. The award for constructive participation in the activities of the Division for many years was presented to Dr. Stericker on September 5 at the Division dinner at the National ACS Meeting in Chicago.

ROHM & HAAS CO.

Thirteen case histories of installations using Amberlite 200 cation exchange resin are reported in a technical bulletin published by Rohm & Haas Co., Washington Square, Philadelphia 5, Pa. Examples include softening, deionization, and special applications in aggressive and oxidative streams and demonstrate the exceptional chemical and physical stability of Amberlite 200 under a variety of extreme conditions.

Amberlite 200, like conventional resins, is a sulfonated styrene-divinyl-benzene copolymer. However, the structure represents an entirely new concept in polymer chemistry which sets Amberlite 200 in a category completely apart from cation exchange resins previously available. This new resin is particularly recommended for use in treating water supplies or industrial wastes that cause standard resins to de-crosslink or fracture.

ROOTS-CONNERSVILLE BLOWER

Roots-Connersville Blower, Division of Dresser Industries, Inc., has announced the opening of a new branch

office in Midland, Tex. **LeRoy C. Laycock,** formerly of the Roots Houston Office, has been appointed branch manager.

HENRY SIMON, LTD.

New Simon Sheet Stacker

A new Simon sheet stacker for printer slotters has been introduced to the market by Henry Simon Ltd., Cheadle Health, Stockport, Cheshire, England, manufacturers of Simon-Hooper corrugated-container machinery. Models are available for handling the following three maximum sheet sizes: 48 by 78 in. (122 by 198 cm.), 62 by 113½ in. (157 by 288 cm.), and 72 by 140 in. (183 by 356 cm.).

SPROUT, WALDRON & CO., INC.

Knife Cutter

The availability of a new style 18 in. knife cutter has been announced by Sprout, Waldron & Co., Inc., Muncy, Pa. With this cutter, the user is now able to feed the stock in sheet form through a roll feeder or in granular or lump form through the wide throat hopper. This unit, in either cast iron or cast steel construction, has a maximum of 30 hp. As in earlier models, this cutter is especially qualified for chopping, granulating, flocking, and other operations.

STICKLE STEAM SPECIALTIES CO.

A new device to prevent overheating of paper machine driers during breaks in paper is offered by Stickle Steam Specialties Co., Indianapolis, Ind. Known as the Automatic Shift-Break Detector, it employs a photoelectric eye aimed at the sheet passing over the driers. The instant a break occurs, steam flow into the driers is automatically reduced to a preset level, as control is shifted from "automatic" to "pressure." Constant pressure is maintained until the sheet is brought back over the machine. Then, control is automatically returned to its former "automatic" status and normal steam flow is resumed. The detector is designed for use with any Stickle pneumatic moisture control system. Breaks are signaled in the control cabinet by a red light. A horn or bell may be used with the detector for indicating wet end breaks.

STOWE-WOODWARD, INC.

David W. Stapleton, president, Stowe-Woodward, Inc., Newton Upper Falls, Mass., has become a founding member of the Presidents' Professional Association, an affiliate of the American Management Association.

Mr. Stapleton is among the first chief executive officers to join the association, a nonprofit organization dedicated to research and educational activities for "enlightened and professional chief executives," and designed to assist him in the performance of his unique responsibilities as top manager.

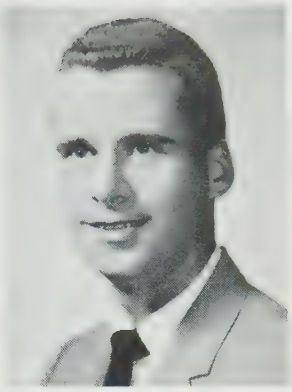
Commentators have described the job of corporation president as "the loneliest in business and industry." Participation is not limited to heads of industrial and business organizations, but will include chief executives who have final responsibility for educational, political, and philanthropic groups. The new association will be guided by a planning council composed of the chief executive officers of 43 companies with assets ranging from $3 million to more than $2 billion. The members also will be eligible to attend the Management Course for Presidents, and the Presidents' Round Tables. The new Association will produce a number of research reports annually and will provide facilities for individual study.

TAYLOR INSTRUMENT COS.

Electronic Control Stations

Electronic indicating control stations for 24 and 1-v. systems are being announced by Taylor Instrument Cos. as an expansion to their existing electronic line. The new 701K series of control stations feature large, full-scale process indication, a complete manual power supply, and a compact design for panel mounting. For further information, write to Taylor Instrument Cos., Rochester 1, N. Y., and request Bulletin 98393.

David W. Stapleton, Stowe-Woodward, Inc.



T. F. Rogers, Virginia Chemicals & Smelting Co.

TESTING MACHINES, INC.

Tension Measuring Equipment

Tension is a common problem in coil winding, printing, wire and yarn production, manufacturing capacitors—whenever sheet or strand materials are processed.

Now Testing Machines, Inc., offers a data sheet which illustrates and describes three different tension meters for checking tensions in paper, plastics, and fabrics as well as wire, cable, and cord.

Also described in this data sheet is the new Saxl Electronic Tension Recorder which shows the dynamic tension changes of moving wires, cables, and cords. This unit makes possible for the first time objective tension measurements during yarn spinning without breaking the roving, by using a micrometer fine adjustment for the sensing unit.

For complete details write to Testing Machines, Inc., 72 Jericho Turnpike, Mineola, N. Y.

TIDLAND MACHINE CO.

Appointment of **D. D. Meyers** to the position of research and development engineer for Tidland Machine Co. has just been announced by its president, A. T. Williams.

VIRGINIA CHEMICALS & SMELTING CO.

Thomas F. Rogers, formerly with Cargill, Inc., of Norfolk, recently joined the Virginia Chemicals & Smelting Co.'s staff as a technical service representative.

WALLACE & TIERNAN, INC.

New Residual Chlorine Indicator

A new indicator for measuring chlorine residuals has just been released by Wallace & Tiernan, Inc., 25 Main St., Bellville 9, N. J. The Series A-780 residual chlorine indicator is an electrochemical instrument which analyzes treated water continuously. Residual chlorine (free or total) acts on a pair of electrodes in a sampling cell. A d.c. current proportional to the residual in a continuous sample is produced. This current controls an electronic indicator. The system is direct, uncomplicated, accurate and will register the slightest residual change (sensitivity is 0.01 p.p.m.) within 10 sec. after the sample water enters the instrument.

The W&T indicator may be furnished in any of three arrangements: to indicate residuals only; to indicate residual values and control alarms; and to indicate residual values and control chlorinator output.

General

Pulp, Paper, and Board—1960*

Paper and board production in 1960 amounted to 34,461 thousand short tons or 1% above the 1959 figure of 34,054 thousand tons.

Production of paper grades totaled 15,414 thousand tons in 1960, an increase of 2% over the 1959 output of 15,071 thousand tons. Trends were mixed for major grades of paper, ranging from gains of 10% for paper-machine coated papers to losses of approximately 2% for book paper, uncoated, and tissue paper, except sanitary and thin.

The output of paperboard amounted to 15,668 thousand tons, a 1% increase over the 15,480 thousand tons reported for 1959. The major grades of board showing the largest increases over 1959, both in absolute and relative terms, were container board and special food board with 2% gains. On the other hand, setup boxboard, insulating and hard pressed board showed losses of 3 and 6%, respectively.

The leading paper and board producing State was Wisconsin, with 2225 thousand tons; ranking second was Georgia with 2047 thousand tons. Alabama, California, Florida, Louisiana, Maine, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, and Washington also produced over a million tons.

Wood pulp production amounted to 25,316 thousand tons in 1960, compared to the 1959 output of 24,383 thousand tons. The leading pulp producing State was Washington with a production of 3087 thousand tons. Other States producing over a million tons were Alabama, Florida, Georgia, Louisiana, Maine, Mississippi, North Carolina, Oregon, South Carolina, Virginia, and Wisconsin.

Consumption of wood pulp in paper and board manufacture totaled 25,700 thousand tons in 1960. Wood pulp inventories at paper and board mills at the close of the year amounted to 532 thousand tons.

Pulpwood receipts during 1960 amounted to 41,370 thousand cords, an increase of 9% over the 1959 receipts of 38,061 thousand cords. Consumption of pulpwood during 1960 amounted to 40,485 thousand cords, 5% above the 1959 consumption level of 38,691 thousand cords. Pulpwood inventories on Dec. 31, 1960, of 5984 thousand cords showed an increase of approximately 811 thousand cords, or 16% above the Dec. 31, 1959, inventories.

Consumption of waste paper totaled 9032 thousand tons in 1960, a decline of 4% from the 1959 consumption of 9414 thousand tons. Waste paper inventories at paper and board mills at the close of the year amounted to 574 thousand tons, a 7% decrease from 1959.

The data presented in this publication continue the annual series established by the Bureau of the Census for the pulp, paper, and board industry in 1930.

As in previous publications of this series, the data on paper and board production pertain to primary operations only: that is, paper and board as it leaves the cutting, reeling, trimming, sorting, or supercalendaring operations directly behind the machine. Also, all clay coated boards and paper coated on the paper machine are considered primary products as are building boards and flexible paper insulation. A number of grade designations are expressed in terms of converted products, but refer to the basis stock as described above.

All measurements of paper and board are in terms of the finished production: that is, machine production less machine and finishing room waste. Wood pulp is measured in tons of 2000 lb. air dry. Pulpwood is measured in cords of 128 cu. ft. rough-wood basis, and all other fibrous materials are measured in tons of 2000 lb. as received at the mill.

Any inquiries concerning these data should be addressed to the U. S. Department of Commerce, Bureau of the Census, Industry Division, Washington 25, D. C.

* Current Industrial Reports Series M26A(60)-13.

U. S. Forest Products Laboratory

A report dealing with the use of balsam fir in sulfate pulping is one of three new publications recently issued by the U. S. Forest Products Laboratory, maintained here by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Wisconsin.

"Sulfate Pulping of Balsam Fir," Laboratory Report No. 2225, points out that this northern softwood has long been considered excellent for use in sulfate pulping, but it has not been used extensively for such pulping because of its low density, limited availability and relatively high cost. The volume of balsam fir, however, is continually increasing, and the species is assuming greater economic importance. Laboratory studies were therefore undertaken to obtain additional data on the sulfate pulping of this wood.

"Method of Determining Specific Gravity of Small Wood Chips," Laboratory Report No. 2209, details a Laboratory modification of a present standard method for determining the specific gravity of fine wood particles.

The third publication, "List of Publications on the Seasoning of Wood," Laboratory Report No. 446, provides an up-to-date file on source material that is available on this subject.

Single copies of these Laboratory publications may be obtained by writing to the Director, U. S. Forest Products Laboratory, Madison 5, Wis.

Corn Industries Research Foundation, Inc.

Corn Industries Research Foundation, Inc., of Washington, was named by the American Society of Association Executives as one of three Grand Award winners for "outstanding public-service programs," in competition with numerous other associations.

CIRF, representing associations in the "Over $250,000 Budget per Year" classification, was cited for its "outstanding contribution in revising and publishing standard analytical procedures for research in the corn-refining industry, and which proved of inestimable value to government agencies, laboratories, libraries, consultants, etc., both within and outside the industry, domestically and internationally."

National Bureau of Standards

The National Bureau of Standards has received an appropriation of $1,000,000 of U. S.-owned foreign currencies to be used for scientific research in foreign countries. Dr. Franz L. Alt, coordinator of Special International Programs, will handle the establishment and operation of the projects.

This is the first time the National Bureau of Standards has received an appropriation from the foreign currency funds which have accumulated from the sale of U. S. surplus agricultural products to foreign governments.

The research programs will be undertaken in India, Pakistan, and Israel and will include projects which complement and supplement the research programs undertaken in the Bureau's laboratories. In establishing the program, Dr. Alt will work through the State Department, U. S. Embassies, and the governments of the countries involved.

Safety Rules for Caustic Soda

A new wall chart listing safety precautions in handling anhydrous caustic soda has been issued by the Solvay Process Division of Allied Chemical Corp.

The red and black chart clearly specifies these four measures that should be followed to avoid accidents when using caustic soda:

1. Avoid contact with body or clothing and do not swallow caustic soda.
2. Wear close-fitting industrial goggles or face shield.
3. Wear rubber gloves, rubber safety-toe shoes or boots, and rubber apron. Rubber, rubberized, or neoprene materials are satisfactory.
4. Wear cotton clothing, not wool.

Charts may be obtained by requesting copy A-119, Solvay Process Division, Allied Chemical Corp., 61 Broadway, New York 6, N. Y.

DIVISIONS AND COMMITTEES

Authorized Committee Assignments

The following new committee assignments were made during September, 1961. The total number of assignments now active in the 64 TAPPI technical committees is about 400. An identifying number is given by TAPPI Headquarters to each work assignment made by a committee chairman and approved by the appropriate division chairman. Assignment numbers should be requested for all activities of technical divisions.

Assignment no.	*Committee*	*Title and objective*	*Committeeman in charge*
		PAPER AND BOARD MANUFACTURE DIVISION	
5002	Fourdrinier	Survey of Web Defect Sensing Equipment. Review process for automatic web defect detection.	J. E. Schad
		PULP MANUFACTURE DIVISION	
6007	Mechanical pulping	5th International Mechanical Pulping Conference (1964). To hold a jointly sponsored conference on the Canadian West Coast, cosponsored by Technical Section, CPPA.	
		TESTING DIVISION	
8028	Paperboard Testing	Measurement of Moisture Content of Laminated and Plastic Coated Board. To develop a method of moisture measurement.	H. LaDue
8029	Release Paper Testing	Adhesive Investigation (PSA Masses). Study various PSA masses on various release coated papers in attempt to arrive at a standard mass for the standard release paper test.	E. Wielock
8030	Release Paper Testing	Experiment Design for Round Robin Testing Program. Facilitate reaching a standard test with no loss of time in preliminary investigation due to unnecessary testing.	R. B. Waddell
8031	Paper Shipping Sack Testing	Method of Preparing Wetted Samples of Shipping Sack Paper for Wet-Strength Tests. To develop means of reproducibly preparing wetted shipping sack paper samples prior to performing wet-strength tests.	W. L. Shoemaker

Converting and Consuming Division

Plastic Laminates Committee

The Plastics Laminates Committee met at TAPPI Headquarters, 360 Lexington Ave., New York, N. Y., on Friday, June 2, 1961. The meeting was called to order at 10:00 a.m. by R. H. Doughty, chairman.

The following committee projects and business were reported and discussed:

Project 763: Rate of Penetration Test. Mr. Gilmore, subcommittee chairman, reported that the attachment for electrical evaluation of the end point of saturation had been received. The response of the time to the current is rapid and saturation tests using a triethanolamine-water solution give as good precision as the visual method. Samples of a number of kraft saturating sheets were studied by the conventional visual method and the electrical end-point method. The visual method gives an initial and a final end point while the electrical method gives only one value and this falls between the other two values. The electrical end point seems to bear a closer relationship to the visual initial end point than to the visual final value. Some brief work is being undertaken with a recording microammeter to study the current response with time for various sheets. When more is learned of this phenomenon it may be possible to size the relay in the time circuit to provide an end point with more meaning, or possibly a series of end points for plotting a saturation curve. Unfortunately, the glass test plate was broken after the initial trials. Mr. Gilmore is securing duplicates locally. It was suggested that a plastic plate be used, but the idea was tabled because the effect of test fluids is not known and glass plates are readily available.

Project 764: Determination of Resin Solids in Laminates. It was stated that the round-robin beta-naphthol test for phenolic resin content of laminates was not successful. It was also stated that the solvent was suitable for some resins, but not for all. Mr. Elmer reported that much work had been done on two-step resins while most laminates were made with one-step resins. Mr. More is to check into the work done on one- and two-step resins while Mr. Seiler is to continue a literature search into methods and solvents for laminate extractions. Reference was made to an article by Wallhauser on the extraction of Novalak and Resolve with cyclohexanol and Mr. Elmer suggested that this approach be studied. The article appeared in *Kunststoffe*, 49: 171–173 (April, 1959). Miss Reidy is to secure copies for translation from German by Messrs. Doughty and Fuerst. A question was raised as to the reasons for lack of precision of the round-robin data. Surface area exposed because of differences in grinding and the level of precision of saturation were offered as possible causes but no further conclusions were reached.

Project 765: Resin Distribution. Dr. Marton reported on studies of treated and untreated paper samples. The work was concerned with the location of plastics in the paper, and the structure of papers and fibers. Samples of each type paper were imbedded in methacrylate and 10 μ thick cross sections prepared. The sections were examined by phase contrast microscopy methods under polarized light. Dr. Marton showed excellent color slides of her work and pointed out that the structure of the untreated paper was much more firm. Other apparent differences between treated and untreated papers were also noted. Of particular interest was

the appearance of the surface of the sheets and a study is planned utilizing an electron microscope and shadowing methods to study paper surface and the action of the resin in this phenomenon. The question of studying the various treated papers by irradiation of the resins with a cobalt 60 source was discussed, but it was suggested that this technique might possibly degrade the resin or change the color. Dr. Marton plans to investigate techniques for staining sections of treated and untreated papers. Two major problems must be resolved. The stains or dyes must be substantive to either the resin or the cellulose, and the stained sample must be very intense because of the translucent effect of sectioning when preparing thin sections. A discussion followed on possible ways to produce a well-stained treated paper to show differences in treatments. Messrs. Fuerst and Seiler will continue to work closely with Dr. Marton on this project.

Other Business

At the previous meeting of the committee, the secretary was delegated to find and summarize the original survey of testing methods conducted in 1953 or 1954. The secretary contacted various persons who were involved then. V. T. Stannett reported that the original replies had been destroyed and that only a summary remained, a copy of which is appended to these minutes.

The matter of committee membership was brought up by the chairman. A letter had been prepared and approved to circularize members who have not attended recent meetings, and who are still carried on the committee listing in the TAPPI Yearbook. Each recipient has been asked to advise the committee of his interest in its work and his future status with the committee. (*Secretary's Note:* The letters have been mailed, and all but three persons have responded. When information is completed, a new listing of members will be issued.)

The various committee projects were reviewed and updated to conform to the new TAPPI project numbering system.

The chairman reported that three potential papers have been solicited for the Plastic Laminates session at the 16th Annual Plastics-Paper Conference at the French Lick Springs-Sheraton Hotel, French Lick, Ind., Oct. 9–11, 1961. The planning and publicity for the conference are well advanced and it promises to be up to the standards set in previous years.

It was moved and agreed that the committee continue to hold regular meetings three times a year—during Paper Week in February, during the early summer (generally June), and during the Plastics-Paper Conference (September or October), to conduct business.

D. M. Gilmore, *Secretary*

Summary of Resin Testing Methods Survey

1. Company name (Optional)
   13 gave name, 10 did not
2. If a study of resin absorption by various types of resin were to be made, which type of resin noted below would you be most interested in?

(a)	Phenolic	20	Polyester	3
	Urea	6	Silicone	1
	Melamine	11		
(b)	Water soluble	8		
	Alcohol soluble	9		
	Both water and alcohol soluble	14		
	Monomer	3		
(c)	Powdered resin (to be dissolved before use)	10		
	Liquid resin	21		

   (If interest is divided and unequal, indicate principal interest by circling box opposite type.)
3. Roughly what per cent resin do you generally desire in your paper before laminating?

25–50%	11
50–75%	5

4. For initial work in a group testing program, which would you prefer to be used as a standard?

Filter paper	14	Any preference?	——
Samples of standard saturating papers	17	Any preference?	2 alpha 1 kraft
Other	0		

5. What are the average temperature and humidity conditions where you test and treat your paper, when outside of a controlled humidity room?
   Summer...75–90°F. 60–90% R.H.\ Covers nearly all
   Winter....65–75°F. 30–70% R.H.\ replies
6. Do you feel a need for information on the effect of humidity on saturating papers?

(a)	Yes	18
	No	1
	Maybe	1
(b)	Which do you prefer for carrying out the tests?	
	Controlled standard humidity	11
	Reported actual humidity	9
	Controlled variable	1
(c)	Are you presently able to control humidity for testing?	
	Yes	11
	No	9

7. What tests do you currently use in evaluating saturating paper?

(a)	Control tests to insure uniformity of absorbency of a standard grade.				
	Basis weight	16		Klemm	13
	Caliper	13		Williams	4
	Density	11		Porosity	14
	Mullen	9		Formation	1
	Tensile	8		Oil absorption	2
	Tear	4		Freeness	1
(b)	Tests used to indicate absorbency of a nonstandard grade.				
	Basis weight	13		Klemm	12
	Caliper	11		Williams	5
	Density	10		Porosity	13
	Mullen	7		Formation	1
	Tensile	5		Oil absorption	1
	Tear	3		Freeness	1

8. What are you principally concerned with in manufacturing and/or treating your absorbent laminating papers? (Rate in order of importance.)

	1	2	3	4
Rate of absorption	9	7	1	0
Total absorption	8	2	6	1
Absorption end point short of total	0	0	0	7
Resin distribution	4	7	5	0
Other				
Formation				
Wet strength				

9. How many types of laminating resins do you regularly use or produce?
   Many produce more than 1, some 100 or more.
10. How many types of absorbent paper for laminating do you regularly use or produce?
    Average 4 or 5, many more than this number.
11. In testing the resin acceptability of paper, do you feel that it is critical for the resin to be applied in a manner similar to production practice, i.e., on the face rather than edgewise?

Yes	17
Both ways	1

12. Have you any special tests for absorbency which you feel are valuable, and which you are willing to describe so that they may be evaluated by the TAPPI subcommittee?

Engineering Division

Fluid Mechanics Committee

On June 1–2, 1961, members of TAPPI's Fluid Mechanics Committee were guests of Bowaters Southern Paper Corp. in Calhoun, Tenn., for a two-day technical and planning conference which was the first held by this group at a paper mill. Visiting with the committee were: TAPPI President Harold Annis, Oxford Paper Co.; M. J. Osborne, Engineering Division chairman, Bowaters Southern Paper Corp.; G. E. Shaad, Engineering Division secretary, General Electric Co.; A. K. Dickerman, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis.; P. J. Thoma, TIME, Inc.; H. Meyer, The Mead Corp.; J. W. Daily, Massachusetts Institute of Technology; C. S. Yih, University of Michigan; H. O. Teeple, TAPPI; J. A. Murphy, International Paper Co., New York, N. Y.; W. T. Bennett, Canadian International Paper Co., Montreal, Que.; J. C. Stewart, Clark & Vicario Corp.; O. R. Witworth, Black-Clawson Co.; R. E. White, Villanova University; S. C. May, Warren Pumps.

Following a mill tour which had been arranged by L. E. Cubertson, Bowaters Southern mill manager, the committee membership and guests were welcomed by V. J. Sutton, Bowaters Southern vice-president and general manager, who emphasized the need for continued research and the application of research results to production for the purpose of cost reduction and improvement of sheet quality.

C. A. Lee, Fluid Mechanics Committee chairman, had originally suggested a joint meeting at a mill because it was felt that his committee members, many of whom take a highly theoretical and analytical approach, would have an opportunity to observe typical and practical mill problems. It was further felt that the mill people would gain an appreciation of research work that is under way and the natural limitations that presently exist. Mr. Lee outlined the objectives of this conference for the group and reviewed the status of the committee's projects and plans for new projects in the mechanics of fluids in the paper making process.

The meeting proper began by the contribution of questions, problems, or suggested research projects by paper mill operating personnel and included, for example:

1. How should a fourdrinier table be set up for best performance and sheet formation, this including setting of forming boards, arrangement of grooved and smooth table rolls, setting of deflectors, and optimum graduation of vacuums in suction boxes?
2. Could not fluid mechanics studies include flow of fluids into as well as out of a porous mat? "Into" would encompass printing problems; "out of" would also include pressing and drying as well as drainage.
3. Is shadow marking or press marking a hydraulics problem?
4. Ink transfer and printability, including the effects of ink viscosity, temperature, humidity, calendering—all from the standpoint of the hydraulics involved.
5. Reduction of much of the existing TAPPI Technical Information Sheets.
6. Relation of "bar marking" to wet end problems.

The fourth question tied in very closely with a suggestion for study in this area by the Coating and Graphic Arts Division of TAPPI.

As a result of the foregoing discussion, the necessity for careful definition of all problems to be considered by the committee was seen as necessary to reduce the possibility of confusion and overlapping of the work of various committees; and of particularly great importance was the need for mill technical personnel to facilitate or implement the use of these research results. This will be done by reducing the technically oriented subject matter to more common terminology for dissemination to production personnel.

V. E. Ware, for the Subcommittee on Pipe Friction, reported on the difficulty in correlating piper friction and shear test data because of the lack of virgin pulp handling data. This committee is to exert special efforts in the near future to get this information so that work in this area can continue.

K. B. Latimer, chairman of the Subcommittee on Membership and Publicity, reported that the survey of hydraulic research efforts which is to accumulate technical data of interest to the committee and the industry in general has received nine replies out of seventeen requests thus far. Efforts are continuing to complete this survey for later publication.

S. G. Mason, chairman of the Subcommittee on Dilute Fiber Suspensions, reported on the progress of this subcommittee's sponsored program at Massachusetts Institute of Technology on northern pulp, southern kraft, and groundwood, and particularly with regard to its investigation into piper friction measurement; flow pattern measuring, distribution and turbulence; and determination of hydraulic action phenomenon through the use of idealized elongated and spherical shaped particles. He also reported that a list of publications originating from this work has been made available to TAPPI members and also requested a very substantial budget for the coming year.

A. C. Spengos, chairman of the Subcommittee on High Speed Flow on Fourdrinier Wire, reviewed this subcommittee's work with Dr. C. S. Yih, discussing the most recent studies at University of Michigan showing that:

1. Streaks from the slice are amplified at the table roll due to normal forces imposed upon the jets by vacuum at the outgoing nip between roll and wire.
2. Further amplification is imparted beyond the region of imposed vacuum due to reverse curvature instability of the free surface.

This committee also requested a substantial budget in order to continue its work including, most particularly, a more detailed study of streak formation at the slice.

G. L. Calehuff, chairman of the Subcommittee on Technical Information, reported that his subcommittee would transmit technical information to TAPPI membership with the help of the new TAPPI Technical Information supervisor. Such information would be derived from three sources: (1) mathematically proved data; (2) operating data established through analysis; (3) general information developed by specific organizations in the industry.

Mr. Wrist then reviewed the Fluid Mechanics Committee technical program which has been planned for the 16th Annual TAPPI Engineering Conference in Washington, D. C.

The third session opened with a brief summary of the possible papers for the 17th Annual Conference in 1962. This was followed by detailed discussion of methods for continuing the improvement in the quality of papers presented at conferences. This is to be implemented by a review of all papers by the entire committee or by a board of review to be set up for that purpose. The committee chairman and vice-chairman are to draft a set of rules subject to approval by the committee for the review by the committee of all papers prior to the Fall, 1961 Conference. However, all subsequent papers will be reviewed prior to presentation at a conference, it being the responsibility of the chairman to implement this process.

Research and Development Division

Microbiological Committee

The Microbiological Committee met Feb. 20, 1961, in New York.

Election of Officers

R. F. Drescher is to continue second year of 2-year term as chairman. B. F. Shema is to continue second year of 2-year term as vice-chairman. M. Legator was re-elected secretary.

Discussion of Research Proposal, "Biological Modification of Lignin"

The status of this 1959 research proposal was reviewed. Possible benefits of this study were jointly defined as follows: (1) improve stream pollution problem, (2) find possible ways of utilizing lignin which is presently a waste problem, (3) biological pulping.

B. Shema proposed we approach the Wood Chemistry Committee to explore possible cooperative phases of this program. Motion entertained, seconded, and passed. Art Stern was appointed delegate to Wood Chemistry Committee meeting.

E. B. Cowding, Yale School of Forestry, believed a study of the possible importance of the polyphenyloxidase systems would be one approach to the problem. Biochemical mutants of known wood-destroying organisms would be used. An attempt would be made to isolate cell-free enzyme system. W. M. Van Horn suggested that Dr. Cowding prepare a cost estimate for this project.

Microbiological Committee

An additional approach to the problem, the screening for lignin degrading organisms, was discussed. Art Stern was asked to submit a proposal to various research groups to determine the cost of this phase of the project.

Soil Burial Test

R. Williams suggested a soil burial test method be submitted for approval. This would be separate from T-487 m-54. "Fungus Resistance of Paper and Paperboard." R. Williams was designated to write up the method and present it to the subcommittee (A. M. Stern and B. F. Shema).

New Business

W. M. Van Horn proposed that we consider short-term projects. This would be in keeping with the suggestion of A. F. Lewis, general chairman, Research and Development Division. Literature survey on selected topics and sponsorship of symposia such as stream pollution problems were discussed as possible projects.

The committee expressed their sincere appreciation to B. F. Shema for the organization of the excellent program.

Marvin Legator, *Secretary*

Testing Division

Paperboard Testing Committee

At the meeting of the Paperboard Testing Committee which was held in Montreal, Que., Aug. 15, 1961, the highlights of the minutes of the February meeting were read. These minutes were approved as published.

Report of the Mullen Subcommittee (C.A. No. 691).

The chairman read the report of Fred deLong, chairman of the mullen subcommittee who noted that the Container Testing Committee had substantially approved the method as prepared by their subcommittee. It was Mr. deLong's recommendation that clamping pressure be specified in the method. The method has been issued for ballot to the Paperboard Testing Committee.

As an alternative to specifying clamping pressure it was suggested that we might specify limits of slip of specimen in the tester or specify a method by which the minimum clamping pressure should be determined for each set of samples. It was urged that the method be adopted with as little delay as possible because we have been so long without a method for paperboard.

Resolved: The subcommittee be advised that the Paperboard Testing Committee recommend that a clamping pressure be specified in the method and that the method be processed as quickly as possible.

Resistance to Tear When Force Is Applied in Cross Direction (C.A. No. 612)

The chairman briefly reviewed the background leading up to the development of a test for tear when the force is applied in the cross direction. The method has been approved by ballot and has been returned by the Standards Committee. Dr. Clark, chairman of the Standards Committee, and Dr. Verseput, chairman of the subcommittee, discussed the points of disagreement with the committee. The following points were resolved:

(a) Scope: No reference is to be made to fiber orientation.

(b) The use of a direct reading scale will be specified with a "note" on how to make the test and the significance of figures if a 16x scale is used.

(c) The section on Precision is to be rewritten as Dr. Clark has advised which is more clear and concise than that written by the Precision Committee. However, the actual data obtained by Dr. Verseput and confirmed by Mr. Bates showing that the variation is about $\pm 6\%$ are to be substituted.

(d) Method is to specify that the liner side of the test specimen is to face the pendulum on all tests unless the tear is the such that the specimen strikes the pendulum in which case the specimen is to be reversed.

Thus the method is now approved as revised by Dr. Clark with no lengthy section on Apparatus but a mere reference to T414. Since these are essentially editorial the method is now ready for publication.

Resolved: The method be published as outlined above.

Bending Properties of Paperboard (C.A. No. 895)

Mr. Lewis distributed revised method to committee for Mr. Eckhart, chairman of subcommittee. Changes were made at suggestion of Mr. Brandon on removing specimen from conditioning chamber and conditions of folding.

A comment was made regarding a check that the press meets the stop on all tests. At times it is necessary to use a 2 or 3 in. wide specimen in the 3 point rule section when the press does not meet the stops. It was suggested that a description of this check could be incorporated into the section on sample width. This would give a reason for the different specimen widths.

For clarity it was suggested that the tolerances and preconditioning humidity be expressed at $32^1/_2 \pm 2^1/_2\%$.

These suggestions are to be incorporated into a revision which when sent to M. A. Burnston will be distributed to the committee for ballot.

Breaking Properties of Scores (C.A. No. 905)

The subcommittee report by W. O. Kroeschell told that a third round-robin had been completed and the conclusion of the three series could not differentiate between the Ohio

Paperboard Testing Committee

Boxboard tester and the Marathon type tester in predicting score performance. Both types appear to rate scores in the same order.

Since it was the purpose of this task group to devise a test method for scored stiffness the subcommittee recommends that R. C. methods be written for both type of instrument and that the project be closed. Thus as the instruments gain more use, the project can be reactivated and perhaps a suggested standard written.

Bill Schoenberg has already written a method for the Ohio Boxboard instrument and he was asked to submit this as an R. C. method. However, an R. C. method has already been published.

W. O. Kroeschell is to cooperate with John Teeple in writing a method for the Marathon type tester.

Printability—Compressability—Smoothness

No action.

Tensile Energy Absorption

No report.

Routine Control (R. C.) Methods

Mr. Cassiday requested members submit methods to him.

Gluability of Paperboard

No report—project chairman is aware of work of other organizations in this field.

Joint Curl Committee

No meeting. Ward Verseput is our representative. The subject is being studied to see what type of program can be adopted.

Other Projects

1. Ply-Bonding Testing. Mr. Luey reported on work being done by the Boxboard Research Organization on ply-bond testing. This work points out the need for a pretreatment with rollers to determine the susceptibility of the paperboard to delamination prior to actual test by one of the established methods. Since this work is being pursued by other organizations, it was agreed not to elevate ply-bond testing to project status at this time.

It was pointed out that test areas for the ply-bond mullen test as published by Dr. Verseput, is used by various companies, and, as provided for in the specimen cutter sold by Testing Machines Inc., do not agree.

2. Moisture Measurement on Laminated Board. There being considerable interest in a method of measurement of moisture content of plastic coated board and laminated board it was decided to initiate a committee assignment to develop such a method. Mr. LaDue accepted the chairmanship of the task committee.

New Business

1. Measurement of Moisture Content of Paperboard on a Moving Web. Mr. Lewis advanced this subject and there was considerable interest on the part of the committee; therefore a project was proposed to study this problem. There is a definite need for a better means of measuring moisture on a moving web. Perhaps this is a subject requiring joint action by various committees even in separate divisions of TAPPI. It may require research funds to reach a solution. As a first step, however, it is necessary to determine a reliable method of moisture measurement that can be applied to moving webs. Mr. Lewis accepted the chairmanship of the task committee and Mr. Watson agreed to serve on the committee.

2. The chairman asked for a vote of preference on whether the committee wanted to hold a technical session at the Annual Meeting either alone or jointly with the Cylinder Committee or whether a technical session at the 1962 Testing Conference was desired. There was some interest in a Technical Session at the Annual Meeting. The chairman will explore this possibility.

Review of the Methods under Jurisdiction of This Committee

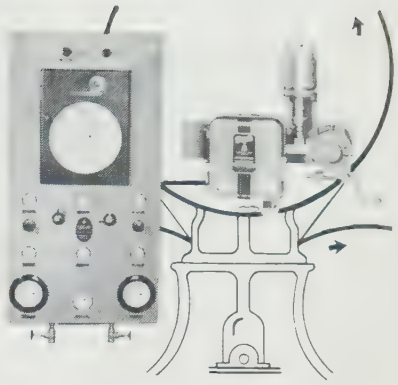
The preliminary review made by Mr. Marth was noted and also the fact that he has been in correspondence with the Steering Committee regarding this jurisdiction for a review of all 400 methods and a possible reassignment of some. This request had not been considered by the Steering Committee and since there were already enough projects to consider, the review was tabled until next meeting prior to which the Steering Committee should have made some decision. Mr. Burnston pointed out that this might well be an assignment to the group chairman.

Under the plan adopted by the Testing Division ballots are to be sent out on all suggested methods as to whether they are to be elevated to tentative standards and on tentative standards to be elevated to standards prior to each meeting when they have been in effect a specified period. The results of this ballot are to be discussed at the meeting and a decision made to elevate, rewrite, or defer action. In addition standards are to be balloted on at least every 5 years and must be studied when no action has been taken for 9 years.

The chairman stated that he had been asked to serve as group chairman for Paper and Paperboard on the Steering Committee but had deferred decision because of change of employment. At any rate he will be resigning as chairman and will recommend to the president of TAPPI that D. E. Marth be appointed chairman. This not being on the agenda, it was decided to defer election of a new vice-chairman and secretary until the February meeting.

A. T. Luey
Secretary pro-tem

You don't need an electronic technician to run this moisture control system



It's the most simple, trouble-free system ever built . . . yet it maintains any moisture content desired in any weight of paper

The Stickle Pres-ten-trol uses the time-tested, mill-proven principle of sheet expansion and contraction to regulate steam flow to the dryers . . . for any weight of paper from .0003 to the heaviest board. It provides instant regulation with minimum fluctuation . . . records moisture variation, steam pressure in dryers, time and duration of wet end breaks . . . holds steam pressure desired when paper is off the machine. On a recent 24-hour test, moisture content varied only 3/10 of 1%. Yet, no other system costs so little to buy, install, operate and maintain, because no other is so simple, so trouble-free. Write for Bulletin 460-C.

STICKLE STEAM SPECIALTIES CO.
2209 Valley Avenue
Indianapolis 18, Indiana

EMPLOYMENT SERVICE

The rates per issue for Positions Open advertisements in *Tappi* are as follows:

Per line	$ 3
1/16-page Box	$ 50
1/8-page Box	$ 80
1/4-page Box	$125

Positions Wanted

E546-61. Electrical Engineer—20 years experience. 11 years as manufactures field service engineer, 9 years as supervisor of electric department in kraft pulp and paper mill. Desires opportunity for future growth.

Positions Open

P2037-61. Research and development, excellent opportunity for development chemist to work on special paper assignments and follow projects to completion through production. Paper school graduate or chemical engineering background preferred.

P2044-61. Progressive, technically-oriented company needs man with broad pulp and paper industry experience to lead growth into specialty chemicals for that field. Formulating experience with wax emulsions valuable. Location: Memphis. Salary: attractive. Send résumé to R. E. Branch, Manager, Technical Service and Development Department, Chapman Chemical Company, 416 Brooks Road, Memphis 9, Tennessee.

SALES ENGINEER

APPLETON MACHINE COMPANY . . .long an outstanding builder of Supercalenders, is seeking a SALES ENGINEER with experience in paper mill finishing room, or its machinery. Must be FREE TO TRAVEL extensively while located at home office in the Fox River Valley —heart of the Paper Industry. Send résumé to **VICE PRESIDENT, SALES —APPLETON MACHINE COMPANY, BOX 468, APPLETON, WISCONSIN.**

(P2045-61)

CHEMIST or CHEMICAL ENGINEER

We are seeking a graduate Chemist or Chemical Engineer with three to five years' experience in a paperboard mill. Duties involve process and technical work in a folding box board mill and provide an opportunity for a competent and ambitious man to advance into production or technical supervision. Excellent benefits and starting salary. Submit replies outlining education, experience and earnings history to: **Personnel Director, CONSOLIDATED PAPER COMPANY, Monroe, Michigan**

(P2046-61)

Physical or Organic Chemist

Creative physical or organic chemist with M.S. or Ph.D. or equivalent in experience wanted for research on products utilizing petroleum wax. Recent polymer developments have opened doors for research on novel wax applications. Experience in wax or polymer coatings, polymer applications, or packaging research beneficial but not essential.

This position is with the expanding Research Department of a major oil company in a friendly southwestern city of 25,000 Applicants with initiative and drive will find challenging opportunities for professional advancement. Excellent research facilities. Comprehensive employee benefits.

Confidential consideration: Send complete résumé of education, experience, and salary requirements to: **Personnel Relations Department No. 4, Continental Oil Company, Ponca City, Oklahoma. (P2047-61)**

CHEMIST

CHEMIST RESEARCH

Progressive, rapidly growing Company has opening for B.S. in Chemistry or Chemical Engineering. Will work on paper coating formulation and process improvement. Broad opportunity to carry out laboratory work and follow through on mill application. Knowledge of printing desirable.

RESEARCH CHEMIST

Should have M.S. or Ph.D. in Chemistry. Will occupy position of Section Head in laboratory reporting to Assistant Technical Director. Experience in aqueous and non-aqueous coatings and/or paper manufacturing desirable. Must be creative and possess initiative.

Send résumé in confidence to: **William A. Siekman, The Appleton Coated Paper Company, Appleton, Wisconsin. (P2048-51)**

PROJECT ENGINEER

Multi-plant pulp and paper company has opening for Project Engineer offering excellent opportunity in large modern plant located in Alabama. Operations include pulp mill, paper mill, board mill and converting. We are seeking a graduate Mechanical Engineer experienced in this field who has potential to move up within our company. Please send resume of experience, education and salary requirements. Information will be held in confidence, and should be forwarded to:

Industrial Relations
Marathon Southern Corporation
A Division of American Can Company
P. O. Box 315
Butler, Alabama

(P2049-61)

NEEDED:

Energetic young men for challenging diversified work in one of the newest and best equipped paper research and development laboratories. The broad objective of the laboratories is to provide technological service for the paper industry in fields relating to chemical additives used in manufacturing and coating paper and paperboard. Fundamental and applied research as well as development projects are undertaken. Travel for co-operative studies at paper mill sites will be necessary at times but such problems will usually be assigned only to those who enjoy travel. We are seeking either B.D. or M.S. graduates from a university offering specific courses in pulp and paper technology or Chemists or Chemical Engineers from other universities who have had papermaking experience. Interviews at our laboratory location will be arranged at our expense. All replies will be considered strictly confidential. Phone or wire collect or write

THE GLIDDEN COMPANY

Chemicals Group—Pigments & Color Dept.
3901 Hawkins Point Rd., Baltimore 26, Md.
Phone ELgin 5-8400
A. C. Dreshfield, Sr., Director of Pulp & Paper Research Laboratories

(P2050-61)

RESEARCH CHEMIST OR ENGINEER OR PROCESS ENGINEER

are wanted by **NEKOOSA-EDWARDS PAPER COMPANY**, one of the most progressive companies in the manufacture of fine business and printing papers and technical specialty papers. They may be recent graduates or men with a few years's experience. Location of the mills is in the heart of central Wisconsin in a small community with outstanding recreational facilities.

RESEARCH CHEMIST OR ENGINEER
Position may be filled by graduate chemist or chemical engineer who has a good background in fundamentals and creative ability. Good opportunity for advancement in either manufacturing or in technical and research departments.

PROCESS ENGINEER
Position may be filled by a graduate in chemical engineering or in paper technology who is interested in working in the paper mill with problems connected with modern, high-speed manufacture of paper. Excellent training for a man interested in going into paper mill supervision or into paper research.

Please send your résumé to:

Employment Director
Nekoosa-Edwards Paper Company
Port Edwards, Wisconsin (P2051-61)

SALES REPRESENTATIVES

Starch manufacturer has an opening in the Mid-Western United States and one in the Eastern United States for technically qualified sales representatives to call on the paper mills.

The man selected for either of these positions must be able to apply his knowledge of paper making and coating to the sale of starches for all such applications.

The position holds excellent promise for growth and advancement with a progressive company in an expanding program.

All expenses paid, company car, profit sharing, pension plan and insurance programs.

Please reply with full resume to **P2053-61, Tappi, 360 Lexington Ave., New York 17, N. Y.**

PHYSICAL CHEMIST

Ph.D. or equivalent required with advanced training and interest in the chemistry and physics of surfaces. Prefer a man skilled in optical techniques to build understanding of the forming of polymer systems into barrier layers.

PHYSICIST OR PHYSICAL CHEMIST

Require a Ph.D. or equivalent with an interest in rheological behavior of fiber systems to lead studies of treatment and behavior of pulp and other fibers in suspension.

These positions are available as a result of the recognition by a major producer of pulp, paper and packaging materials webs of the need for fundamental understanding to guide, improve and generate production. They will be part of a growing effort to be based on technical excellence. New laboratory facilities are being created in a rural location adjacent to several major metropolitan centers.

Please address all replies in absolute confidence to P2052-61, *Tappi*, 360 Lexington Ave., New York 17, N. Y.

. . . WANTED . . .

R. & D. CHEMIST

with Strong Background in

PAPER TECHNOLOGY

and Interest in Chemical Applications to Paper, Films, Foils, Etc.

TO $10,000 START

Plus Liberal Profit Sharing and Bonus

Our client, a leading Midwest chemical company internationally known in the field of volatile corrosion inhibitors, is expanding the new product development program of its industrial division to broaden the base of its activities in the area of the application of coatings and impregnations to paper, film, foil, laminates, etc.

Though very well staffed with organic chemists in its other divisions, Client company does not now have a technician with paper background. The new man will be the expert in this area, with a strong voice in the directionalizing of R. & D. activities involving paper and similar substances.

Client company thinks basically in terms of patentable applications and products—and liberally rewards its R. & D. people for development of saleable items. Accordingly, this position offers tempting financial potentials to a creative-minded paper chemist capable of developing commerically feasible applications of chemicals to flat, flexible materials.

Make initial inquiry in duplicate to Mr. George M. Sunday personally, enclosing two copies of comprehensive resume detailing; education; professional affiliations; and chronological treatment of professional and/or business background and experience. Full confidence guaranteed.

SUNDAY, INC.

Personnel Consultants to Management
Pulp, Paper, Packaging & Allied Industries

6 E. Monroe St. **Chicago 3** **AN 3-1970**
J-3
(P2054-61)

WANTED

A DESIGNER OF PULP AND PAPER PROCESSING MACHINERY

A well established designer and manufacturer of highest quality processing and industrial machinery has an opening for a college-trained, well-qualified and thoroughly experienced pulp and paper processing machinery designer.

This is a good job with a reliable and sound firm. It has an excellent potential for the right man. This is not an "average" job and we are not looking for an "average" man.

If you have proven ability and several years experience in this field, and also feel you are interested in a challenge with both a solid and a rewarding future —

WRITE TO BOX P2058-61

% TAPPI, 360 LEXINGTON AVENUE, NEW YORK 17, NEW YORK

8862

LOCAL SECTION ACTIVITIES

Meeting Calendar

November, 1961

14 Bay District, New England Section, Center Building, Arthur D. Little, Inc., Concord Turnpike (Route 2), Cambridge, Mass. "Isolating Paper Odors," by David A. Kendall, Arthur D. Little, Inc., Food and Flavor Section. Visit to laboratories, beginning about 5:30 p.m., will precede the dinner.

14 Pacific Section, Longview, Wash. "Papermaking and Screening."

14 Metropolitan District, Empire State Section, Stouffer's, 100 E. 42nd St., New York, N. Y.

14 Ohio Section, Manchester Hotel, Middletown, Ohio. "Modern Fine Paper Machines." Joint meeting with Miami Valley PIMA.

15 Lake States Section, Appleton Elks Club, Appleton, Wis. "Encapsilated Coatings."

16 Delaware Valley Section, Manufacturers Country Club, Oreland, Pa. "Drying of Paper."

16 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

17–18 Southeastern Section, Biltmore Hotel, Atlanta, Ga.

21 Berkshire District, New England Section, Country Club of Pittsfield (Mass.).

21 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

30 St. Louis Section, Le Chateau, 10405 Clayton Rd., St. Louis, Mo.

30 Lake Erie Section, tour of plant of General Electric Co., Nela Park, Cleveland, Ohio.

December, 1961

1–2 Gulf Coast Section, Battle House, Mobile, Ala.

1 Central District, Empire State Section, University Club, 431 Fayette St., Syracuse, N. Y. "Engineering and Design."

1 Virginia-Carolina Section, Jefferson Hotel, Richmond, Va. Tour of a converting plant in afternoon.

4 Pioneer Valley District, New England Section, Storrowtown Tavern, West Springfield, Mass.

5 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Gloss Printing."

6 Western District, Empire State Section, Crown and Anchor Restaurant, 2901 Pine Ave., Niagara Falls, N. Y. "Black-Clawson Verti-Forma."

7 Kalamazoo Valley Section, Hotel Harris, Kalamazoo, Mich. "Pigment Coating," Afternoon-evening sessions.

12 Metropolitan District, Empire State Section, Stouffers, 100 E. 42nd St., New York, N. Y.

14 Ohio Section, Manchester Hotel, Middletown, Ohio. "The Potential of Mechanical and Chemical Pulps," by Renata Marton, Empire State Paper Research Association, Syracuse, N. Y.

14 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

14 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. "High Density Bleaching of Groundwood," by A. D. Armstrong, St. Regis Paper Co., Deferiet, N. Y.

19 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

January, 1962

5 Central District, Empire State Section, University Club, 431 Fayette St., Syracuse, N. Y. Panel meeting. "On Machine Clay Coated Board."

8 Bay District, New England Section, Armand Restaurant, Framingham, Mass.

9 Lake States Section, Green Bay Elks Club, Green Bay, Wis. "Waste Wood Utilization." Visit to mill of Green Bay Paper & Pulp Co., Green Bay, Wis.

9 Metropolitan District, Empire State Section, Stouffer's, 100 E. 42nd St., New York, N. Y.

9 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Fine Papers."

9 Ohio Section, Manchester Hotel, Middletown, Ohio. "Coating Processes and Technology," by George Booth, Dilts Machine Co., Fulton, N. Y.

11 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. Students' night.

12–13 Gulf Coast Section, Tuscaloosa, Ala.

16 Berkshire District, New England Section, Country Club of Pittsfield (Mass.).

16 Pacific Section, Bellingham, Wash. "Engineering."

16 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

16 Golden Gate Section, San Francisco, Calif. Talk by W. F. Linke, American Cyanamid Co.

18 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

18 Kalamazoo Valley Section, Hotel Harris, Kalamazoo, Mich. Papermakers Get-Together.

19 Southeastern Section, DeSoto Hotel, Savannah, Ga.

February, 1962

1 Lake Erie, Cleveland Engineering Society, 3101 Chester Ave., Cleveland, Ohio. "Industrial Psychology."

2 Central District, Empire State Section, University Club, 431 E. Fayette St., Syracuse, N. Y. "Electron Photomicroscopy of Wood and Wood Fibers."

6 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Testing Instruments Used for Boxboard and Paper," by George Maltenfort, Container Corp. of America, Chicago, Ill.

7 Western District, Empire State Section, Crown and Anchor Restaurant, Niagara Falls, N. Y. "Plastics in the Paper Industry."

8 Ohio Section, Manchester Hotel, Middletown, Ohio. "Computer Control for the Paper Industry," by Charles Carroll and David Kirk, I.B.M. Co.

8 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. "Headbox Hydraulics."

13 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

15 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

March, 1962

1 Kalamazoo Valley Section, Hotel Harris, Kalamazoo, Mich. "Developments in the Graphic Arts."

1 Lake Erie. Plant tour.

2 Central District, Empire State Section, University Club, 431 Fayette St., Syracuse, N. Y. "Instrumentation of Paper Machines," by L. L. Thompson, I.B.M. Research Center, Yorktown Heights, N. Y.

6 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Foamed Plastics as a Packaging Medium."

7 Western District, Empire State Section, Crown and Anchor Restaurant, Niagara Falls, N. Y. "Stream Improvement."

8 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. Junior Award Papers.

12 Bay District, New England Section, Armands Restaurant, Framingham, Mass.

13 Ohio Section, Student Center, Miami University, Oxford, Ohio. "New Fibers from Wood," by Herman Mark, Polymer Research Institute, Brooklyn, N. Y. Joint meeting with Indiana District and students and faculty of Miami University Paper School.

13 Metropolitan District, Empire State Section, Stouffer's, 100 E. 42nd St., New York, N. Y.

13 Lake States Section, Mead Hotel, Wisconsin Rapids, Wis. Panel discussion on "Paper Finishing Operations." Visit to mill of Nekoosa Edwards Paper Co., Port Edwards, Wis.

15 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

16–17 Southeastern Section, Wilmington, N. C. Visit to mill of Riegel Paper Corp., Acme, N. C.

20 Pacific Section, Camas, Wash.

20 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

20 Berkshire District, New England Section, Wendell Sherwood Hotel, Pittsfield, Mass.

20 Golden Gate Section, San Francisco, Calif. Panel discussion on "Functional Coatings."

22 Delaware Valley Section, Manufacturers Country Club, Oreland, Pa. E. G. Albert Award papers.

22–24 Gulf Coast Section, San Carlos Hotel, Pensacola, Fla.

23 Virginia-Carolina Section, John Marshall Hotel, Richmond, Va.

April, 1962

2 Pioneer Valley District, New England Section, Storrowtown Tavern, West Springfield, Mass.

3 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Preprinting of Corrugating Liner."

4 Western District, Empire State Section, Crown and Anchor Restaurant, Niagara Falls, N. Y. Visit to plant of Hazel Atlas Glass Co.

5 Kalamazoo Valley Section, Hotel Harris, Kalamazoo, Mich. "Chemi-Mechanical Pulping."

5 Lake Erie Section, Cleveland Engineering Society 3100 Chester Ave., Cleveland, Ohio.

6 Central District, Empire State Section, University Club, 431 E. Fayette St., Syracuse, N. Y. Senior night and Junior awards.

0 Metropolitan District, Empire State Section, Stouffer's, 100 E. 42nd St., New York, N. Y.

0 Lake States Section, Conway Hotel, Appleton, Wis., C. J. West Memorial Meeting. Tour of facilities of The Institute of Paper Chemistry, "What Should Research be Doing for the Pulp and Paper Industry?"

2 Ohio Section, Manchester Hotel, Middletown, Ohio. "Scientific Approaches to Papermaking," by Jasper Mardon, Oxford Paper Co., West Carrollton, Ohio.

2 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. "Wet-Strength Resins for Paper."
Joint meeting with Beaver Falls Chapter A.I.C.

17 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind.

19 Eastern District, Empire State Section, Queensbury Hotel, Glens Falls, N. Y.

27 Delaware Valley Section, Riegel Ridge Community House, Milford, N. J. Visit to mill of Riegel Paper Corp., Milford, N. J. 2 p.m.

May, 1962

1 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Electro-types, Plate Making."

1 Golden Gate Section, San Francisco, Calif. R. M. True Memorial Lecture by K. Sarkanen, Finland.

4 Central District, Empire State Section, University Club, 431 E. Fayette St., Syracuse, N. Y. Dinner-dance.

5 Western District, Empire State Section. Dinner-dance.

10 Ohio Section, Hartwell Recreation Hall, Cincinnati, Ohio. Dinner-dance.

10 Northern District, Empire State Section, Woodruff Hotel, Watertown, N. Y. Dinner-dance.

11–12 Gulf Coast Section, Edgewater Gulf Hotel, Edgewater Park, Miss. Annual meeting.

15 Berkshire District, New England Section, Country Club of Pittsfield, Mass.

15 Lake States Section, Holiday Inn, Madison, Wis. "Forest Genetics." Visit to Forest Products Laboratory.

17 Pacific Section, Gearhart Hotel, Gearhart, Ore. Annual meeting. Joint meeting with Pacific PIMA.

18–19 Virginia-Carolina Section, Canton, N. C. Visit to mill of Champion Papers, Inc.

25 Metropolitan District, Empire State Section.

25–26 Southeastern Section, Wanderer Motel, Jekyl Island, Ga.

26 Lake Erie Section, Cleveland, Ohio. Annual meeting.

June, 1962

1–2 New England Section, Chatham Bar Arms, Chatham Bar, Mass.

7–9 Empire State Section, Whiteface Inn, Whiteface, N. Y.

1960–61 Activities of the Italian Section

The activities of the Italian Section from July, 1960, to July, 1961, developed mainly along the lines proposed by the various study committees which met throughout the year to discuss problems of basic importance to the Italian paper industry. The results of these studies were presented to the section members for general discussion at the meetings.

July 1, 1960—Milan: "Organization in the Paper Industry" by Mr. Froidevaux, Paul Planus Organization. Attendance: 70 members.

Oct. 29, 1960—Turin: "Report of the Testing Methods Committee on the Relative Humidity for Paper Testing" by Dr. E. Grandis, Cartiere Burgo, chairman of the Testing Methods Committee. Attendance: 68 members.

Dec. 14, 1960—Turin: "Report of the Groundwood Committee on the Activity Developed in 1960" by Dr. D. Borruso, Stazione Sperimentale per la Carta e Cellulosa, chairman of the Groundwood Committee.

March 15, 1961—Turin: General meeting and report of the chairman, Mr. Bersano, on the activity developed by the Italian Section in 1960. Two technical movies on papermaking were shown, followed by a paper "The Human Factor in the Paper Industry."

delivered by Mr. Bersano. Attendance: 65 members.
June 28, 1961—Verona: Meeting on "Paper Printability."
"Some Aspects of Paper Printability" by G. Botto Micca.
"What the 3rd EUCEPA Congress Can Teach the Printability Committee" by A. Tabacchi.
"Connection between Physico-mechanical Properties and Paper Printability" by D. Borruso.
Attendance: 110 members.

Following the Oct. 29, 1960, meeting a questionnaire was sent to all members and to a group of paper consumers requesting information on the problem of relative humidity for

Chairman Piero Bersano presiding at the June 28, 1961 meeting of the Italian Section

paper testing. The Testing Methods Committee is studying the results of this survey now and will report their conclusions to the members at a meeting early in 1962.

The section has also undertaken a technical study of the utilization of small trees and branches by the paper industry.

A committee composed of G. Centola, G. Cerio, and G. Pellegrini was asked to prepare a report on the results of experiments carried out at the "Stazione Sperimentale per la Cellulosa de Carta" in Milan. Funds for these were provided by the section. The report is to be published in a bulletin for distribution to all members. This subject will also be discussed at one of the coming meetings of the section.

The officers of the section have held two meetings to discuss the professional training of Italian paper technicians. At the second meeting Mr. Pantaleo, director of the National Education Centers, described the present operations of Italian technical institutes, stressing both the possibilities and the difficulties that the section would probably face in the development of this program. Obviously this project could not be completed in a short time. The officers resolved, however, to proceed with the preparation of an explanatory text which would be distributed to students at technical schools. An informative movie film will also be prepared for showing at technical schools.

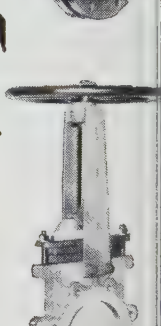
The section is also engaged in the publication of Italian translations of TAPPI Standards and monographs.

There are now 250 members of the Italian Section. The officers and Executive Committee members for 1960–61 are:

Chairman—Piero Bersano, Cartiere Burgo.
Vice-Chairman—Pietro Ghisoni, Cartiere Vita Mayer.
Vice-Chairman—Leto Ridi, Instituto Poligrafico dello Stato.
Secretary and Treasurer—Allessandro Restagno, Cartiere Burgo.
Giorgio Cerio, Cartiera Italiana.
Vittorio Gilberti, Cartiera Donzelli.
Rodolfo Kollar, Cartiere Rossi.
Executive Committee—Edoardo Cirla, Cartiere Binda; Carlo Gregotti, Cartiere di Verona; Giuseppe Villa, Cartiere Villa.

NOW AVAILABLE *in either*

FABRICATED or CAST construction



Only FABRI-VALVE Gives you all these FEATURES!

- Inverted Packing Gland to assure perfect gate alignment (patented).
- Many alloy combinations to combat corrosion EFFECTIVELY.
- Optional O-Ring Seating.
- Surface ground gates for smooth, easy operation.
- Pre-formed, SELF LUBRICATING rubber packing for minimum maintenance.

and many more advantages . . .

WEDGE GATES
STOCK VALVES
BUTTERFLY VALVES
CHECK VALVES
DIGESTER VALVES
V-PORT METERING

TRADE MARK
FABRI-VALVE
COMPANY OF AMERICA
91 N. E. RUSSELL ST.
P. O. BOX 4352, PORTLAND 8, OREGON

UNITED STATES PATENTS ON PAPERMAKING

Second Quarter, 1961

Compiled by The Institute of Paper Chemistry

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired. Or, those desiring the patents on *microcards* should write to The Institute of Paper Chemistry, Appleton, Wisconsin.

April 4, 1961

Anderson, Maynard W. **Push button operated paper towel roll holder.** U. S. pat. 2,978,197. Filed Dec. 1, 1958. 4 claims. [Cl. 242-55.2.]

Anderson, Wilbur G., Jr. **Clearance pad.** U. S. pat. 2,978,163. Filed April 16, 1958. 4 claims. Assigned to Am. Box Board Co. [Cl. 229-14.] A corrugated board pad is used as interior packing in an outer container holding a television set.

Ardner, Robert L. **Wrapper registration control.** U. S. pat. 2,977,730. Filed Aug. 11, 1958. 5 claims. Assigned to Lynch Corp. [Cl. 53–51.]

Barker, Peter W., Heslop, Robert N., Poole, Victor D., and Stephen, William E. **Process for coloring cellulose with new triazine dyestuffs.** U. S. pat. 2,978,289. Filed Aug. 4, 1958. 14 claims. Assigned to Imperial Chem. Inds., Ltd. [Cl. 8-54.2.]

Battista, Orlando A., and Smith, Patricia A. **Level-off D.P. cellulose products.** U. S. pat. 2,978,446. Filed Jan 28, 1957. 15 claims. Assigned to Am. Viscose Corp. [Cl. 260-212.]

Bazler, Seward M. **Production of continuous laminated strips.** U. S. pat. 2,977,620. Filed Nov. 26, 1956. 8 claims. Assigned to General Elec. Co. [Cl. 18-4.] Shaped molded laminates of glass or paper are produced for use as structural parts of autos, planes, or the like.

Bender, Edward J., and Richardson, Howard H. **Device for accurately placing lanes of granules on moving web.** U. S. pat. 2,977,924. Filed March 16, 1954. 2 claims. Assigned to Patent and Licensing Corp. [Cl. 118-8.] The web is asphalt-saturated paper; the process is manufacture of roofing materials.

Bolding, Hubert V. **Packaging folder.** U. S. pat. 2,978,165. Filed July 23, 1959. 8 claims. Assigned to Standard Pkg. Corp. [Cl. 229-87.] A paperboard folder is provided for holding a slab of bacon slices.

Brisley, Frank O., and Evans, Robert E. **Battery separator and method for manufacturing same.** U. S. pat. 2,978,529. Filed Oct. 17, 1955. 10 claims. Assigned to Owens-Corning Fiberglas Corp. [Cl. 136-145.] The separator is formed from a resin-impregnated sheet including both glass and cellulosic fibers.

Brook, Leonard, Lazenby, Edwin H., and Wilson, Peter G. **Wrapping machines.** U. S. pat. 2,977,731. Filed Oct. 20, 1959. 8 claims. Assigned to Forgrove Machinery Co., Ltd., [Cl. 53-74.] The speed of the machine is regulated in accordance with the supply of articles to be wrapped.

Bush, Robert C. **Shipping and display package.** U. S. pat. 2,978,099. Filed Dec. 27, 1957. 1 claim. Assigned to Corning Glass Works. [Cl. 206-65.] This is a carton for dishes or the like.

Clemens, Ludwig. **Stuffing material for packing purposes, and process and device for the manufacture thereof.** U. S. pat. 2,978,006. Filed July 15, 1958. 2 claims. [Cl. 154-32.] A laminate of embossed paper and cellulose wadding is used as interior packing material.

Conti, John D. **Heat sealing method and apparatus.** U. S. pat. 2,978,008. Filed June 1, 1956. 15 claims. Assigned to Am. Viscose Corp. [Cl. 154-42.] This heat-sealing is done in the manufacture of bags.

Cumpston, Edward H., Jr. **Refining machine.** U. S. pat. 2,978,192. Filed March 1, 1957. 4 claims. Assigned to E. D. Jones Corp. [Cl. 241-222.]

Di Maggio, Carmelo A., Healy, James W., and Lamade, Ralph M., Jr. **Tagging apparatus.** U. S. pat. 2,977,862. Filed May 20, 1958. 9 claims. Assigned to Arthur D. Little, Inc. [Cl. 93-87.] Tags are attached to women's hose.

Faix, William C. **Slotter knives and method of making same.** U. S. pat. 2,977,823. Filed Dec. 17, 1958. 9 claims. Assigned to Russell T. Conn. [Cl. 76-101.]

Gibb, Alex S. **Carton making machine.** U. S. pat. 2,977,861. Filed May 20, 1958. 18 claims. Assigned to Continental Can Co., Inc. [Cl. 93-51] A plunger-type machine for forming open-top cartons is constructed to form a variety of sizes of cartons.

Gomsi, Arne E. **Laminated structure and process for preprint same.** U. S. pat. 2,978,356. Filed March 18, 1958. 4 claims. Assigned to General Aniline & Film Corp. [Cl. 117-62.] Cellulose acetate is bonded to a steel backing to form a film-casting surface.

Helland, Howard M. **Fourdrinier machine belt.** U. S. pat. 2,978,023. Filed Nov. 14, 1958. 3 claims. Assigned to Lockport Felt Co., Inc. [Cl. 162-348.] This is a fourdrinier wire designed to prevent plugging with pulp during use.

Hult, Nils R. R., and Broman, Bror O. **Method and apparatus for cleaning heat exchange apparatus connected to receive flue gases from soda recovery-boilers.** U. S. pat. 2,978,378. Filed Nov. 18, 1958. 3 claims. Assigned to Aktiebolaget A. Ekstroms Maskinaffar. [Cl. 162-30.]

Jensen, Thormod. **Bread wrapper sealing device.** U. S. pat. 2,978,007. Filed March 31, 1959. 7 claims. Assigned to St. Regis Paper Co. [Cl. 154-42.]

Knutson, Kermit B. **Tape dispenser.** U. S. pat. 2,978,155. Filed Feb. 19, 1958. 7 claims. [Cl. 225-25.] This is a versatile dispenser for pressure-sensitive adhesive tape.

Lambert, Harry E. **Molded pulp carton.** U. S. pat. 2,978,-162. Filed Feb. 9, 1959. 13 claims. Assigned to Packaging Corp. of America. [Cl. 229-2.5.] This is a reinforced egg carton separable into self-contained halves.

Larson, Stanley C., and Halliday, John J. **Apparatus for winding material with programmed tension.** U. S. pat. 2,978,200. Filed April 26, 1960. 10 claims. Assigned to Johnson & Johnson. [Cl. 242-75.51.] The apparatus slits a web of pressure-sensitive material and rewinds the tapes so formed.

Lefebvre, Jean A. A. **Anti-stripping additive for asphalts.** U. S. pat. 2,978,342. Filed Aug. 27, 1957. 6 claims. Assigned to Esso Research and Eng. Co. [Cl. 106-123.] Lignosulfonates are used.

Limburg, Pieter C., Buurman A., and Vroom, Robert A. **Manufacture of rayon.** U. S. pat. 2,978,292. Filed July 9, 1958. 6 claims. Assigned to Am. Enka Corp. [Cl. 18-54.] The coagulation modifier used comprises a mixture of epoxyalkane polymers and certain amines.

Loderhose, Richard E. **Record jacket with detachable photographs.** U. S. pat. Re. 24,962. Filed July 22, 1960. (Divided; original filed April 5, 1960.) 7 claims. [Cl. 229-70.]

Louderback, Richard G. **Collapsible ornament.** U. S. pat. 2,977,701. Filed June 15, 1959. 1 claim. [Cl. 41-11.] A three-dimensionally shaped article of starlike configuration is formed of paperboard.

Pearce, Lewis C. **Envelope banding machine.** U. S. pat. 2,977,734. Filed Jan. 14, 1957. 26 claims. Assigned to Pearce Devt. Co. [Cl. 53-198.]

Pearce, Lewis C. **Sheet distributing mechanism and receptacle conveyor.** U. S. pat. 2,977,733. Filed Oct. 17, 1957. 42 claims. Assigned to Am. Greetings Corp. [Cl. 53-154.] Greeting cards and envelopes are collated and loaded into different compartments of a container.

Russo, Joseph D., and Weidener, Richard A. **Remoistenable adhesive compositions.** U. S. pat. 2,978,343. Filed Oct. 9, 1958. 2 claims. Assigned to Natl. Starch and Chem. Corp. [Cl. 106-128.] The adhesive is for use in preparing curl-resistant gummed paper.

Stout, Arthur G. **Apparatus for the manufacture of paper.** U. S. pat. 2,977,686. Filed Feb. 19, 1959. 17 claims. Assigned to Jamar-Olmen Co. [Cl. 34-114.] A fully enclosed paper machine hood is provided.

Williams, Russell J., Brady, Charles V., and Ottinger, August F. **Bags.** U. S. pat. 2,978,164. Filed May 22, 1958. 16 claims. Assigned to Bemis Bro. Bag Co. [Cl. 229-66.] A stitched closure for a paper bag is constructed so as to be easily unraveled.

Yaniello, Industrial J. **Roll paper dispenser.** U. S. pat.

2,978,156. Filed May 22, 1959. 3 claims. [Cl. 225-42.] This is a wall-mounted dispenser for paper towels.

Young, Harland H., and Majka, Edward J. **Incorporating oil in hardboard.** U. S. pat. 2,978,382. Filed Nov. 16, 1955. 8 claims. Assigned to Swift & Co. [Cl. 162-179.]

April 11, 1961

Allen, Charles R. **Envelopes.** U. S. pat. 2,979,189. Filed Aug. 8, 1958. 3 claims. [Cl. 206-15.1.] A paper envelope is provided for enclosing the brush portion of a paint brush.

Andren, William. **Dispenser package.** U. S. pat. 2,979,194. Filed May 25, 1959. 19 claims. [Cl. 206-57.] Packages containing stationery items may be stacked and the contents of any package removed without unstacking the packages.

Benedict, Ullman H. **Automatic adhesive applicator for large wrapping paper rolls.** U. S. pat. 2,979,023. Filed April 30, 1959. 5 claims. Assigned to James Lees and Sons Co. [Cl. 118-43.]

Bentov, Itzhak. **Method and apparatus for treating paper.** U. S. pat. 2,979,131. Filed June 10, 1959. 7 claims. Assigned to W. R. Grace & Co. [Cl. 162-361.] Paper is subjected to mechanical stresses which produce a stretchable paper.

Bergstein, Robert M. **Cover lock box.** U. S. pat. 2,979,252. Filed Dec. 30, 1957. 1 claim. Assigned to Bergstein Pkg. Trust. [Cl. 229-47.] A box having a separate telescoping cover is provided with means to lock the cover to the box.

Bonder, Howard. **Display package.** U. S. pat. 2,979,192. Filed March 22, 1960. 5 claims. Assigned to Jaybee Mfg. Corp. [Cl. 206-46.] A paperboard box is provided for the packaging and display of a doorknob assembly.

Brun, Pierre C. E. **Combination package and diffusion device.** U. S. pat. 2,979,268. Filed Dec. 23, 1957. 10 claims. Assigned to Societe Poitevine de Conditionnement (Societe Annonyme). [Cl. 239-55.] An airtight paper envelope is provided for packaging a deodorant or other product.

Bürkner, Wolfgang. **Method and apparatus for producing particle composition products.** U. S. pat. 2,979,105. Filed Jan. 14, 1959. 10 claims. Assigned 50% to Carl Schenck Maschinenfabrik G.m.b.H. [Cl. 154-1.] A mat for processing into wood-particle board is produced.

Chiola, Vincent, and Fink, William C. **Coated photoflash lamp.** U. S. pat. 2,978,890. Filed Jan. 28, 1958. 2 claims. Assigned to Sylvania Elec. Prods., Inc. [Cl. 67-31.] Cellulose acetate is used.

Clark, James Andrew. **Process for producing gas-proof and gas-adsorbent materials and the articles so produced.** U. S. pat. 2,979,157. Filed Oct. 23, 1942. 13 claims. Assigned to Am. Viscose Corp. [Cl. 183-4.] Paper is impregnated with a carrier such as methylcellulose and an adsorbent such as activated carbon.

Cline, Robert C., Rose, Robert G., and Wiands, Clarence L. **Easel forming binder.** U. S. pat. 2,979,343. Filed Oct. 1, 1959. 1 claim. Assigned to F. L. Russell Corp. [Cl. 281-33.] An easel support is provided in the construction of a loose-leaf binder.

Cunningham, James M. **Paper feeding mechanism.** U. S. pat. 2,979,329. Filed Dec. 24, 1959. 2 claims. Assigned to Intern. Business Machines Corp. [Cl. 271-29.]

Drake, George L., Jr., Reeves, Wilson A., and Guthrie, John D. **Fibrous textile cellulosic phosphonomethyl ethers and process of preparation.** U. S. pat. 2,979,374. Filed Oct. 31, 1957. 4 claims. Assigned to the United States of America. [Cl. 8-120.]

Frisosky, Robert F., and Wall, Donald S. **Folding boxes of the tray type.** U. S. pat. 2,979,251. Filed Feb. 11, 1960. 6 claims. Assigned to Procter & Gamble Co. [Cl. 229-34.]

Gill, Lester D. **Box with self locking tab.** U. S. pat. 2,979,-249. Filed June 3, 1959. 10 claims. [Cl. 229-17.] This is a reclosable soap powder carton.

Greig, Harold G. **Electrostatic printing.** U. S. pat. 2,979,-402. Filed July 31, 1956. 13 claims. Assigned to Radio Corp. of Am. [Cl. 96-1.] An electrographic recording paper is provided.

Hobbs, Harry C. **Cartons.** U. S. pat. 2,979,250. Filed Nov. 6, 1959. 24 claims. [Cl. 229-32.] An open-top stackable paperboard carton for packaging berries is provided.

Hopkins, Frank L., and Ayres, Richard H. **Bag top closing and sealing machine.** U. S. pat. 2,978,852. Filed March 7, 1960. 12 claims. Assigned to Bemis Bro. Bag Co. [Cl. 53-137.]

Krestan, Miles F., and White, Robert E. **Web control device.** U. S. pat. 2,979,279. Filed Jan. 13, 1958. 5 claims. Assigned to Triangle Pubs., Inc. [Cl. 242-58.3.] The vibration of a web from an expiring roll being fed to a printing machine is controlled preparatory to a roll-chaining procedure.

Kvassay, Emanuel, and Andrews, James. R. **Container.** U. S. pat. 2,979,191. Filed May 28, 1957. 6 claims. Assigned to William Douglas Sellers. [Cl. 206-45.33.] An open top box of single-face corrugated is provided for packaging a cake.

Levine, Morton. **Case for cartons.** U. S. pat. 2,979,222. Filed June 24, 1959. 3 claims. [Cl. 220-21.] Four filled six-pack cartons are packed in an outer case made of plastic.

Liebeskind, Arthur S. **Foam plastic coated carton.** U. S. pat. 2,979,246. Filed May 7, 1956. 3 claims. Assigned to Lord Baltimore Press, Inc. [Cl. 229-14.] Foamed plastic pads are used as interior packing in a carton.

Liebeskind, Mack. **Pleating apparatus and method.** U. S. pat. 2,979,240. Filed July 6, 1959. 7 claims. Assigned to Ideal Pleating Co. [Cl. 223-30.] A web of textile material is pleated between two webs of tissue paper.

Lurie, August J. **Carton opening device.** U. S. pat. 2,978,807. Filed Sept. 9, 1959. 2 claims. [Cl. 30-2.]

Lytton, Marion R. **Production of rayon.** U. S. pat. 2,979,376. Filed June 29, 1955. 5 claims. Assigned to Am. Viscose Corp. [Cl. 18-54.] The coagulation modifier is an alkylene oxide adduct of *p,p'*-isopropylidenediphenol.

McClay, Gordon F. **Log debarking drum.** U. S. pat. 2,979,090. Filed Nov. 17, 1958. 2 claims. Assigned to Canadian Ingersoll-Rand Co., Ltd. [Cl. 144-208].

MacGregor, Warren S. **Preparation of dialkyl disulfides.** U. S. pat. 2,979, 532. Filed Feb. 9, 1959. 20 claims. Assigned to Crown Zellerbach Corp. [260-608.] Dimethyl sulfide is prepared from methyl mercaptan from pulping effluent.

Noffsinger, Harold E. **Holder for milk cartons.** U. S. pat. 2,979,225. Filed Sept. 15, 1958. 1 claim. [Cl. 220-85.] This is a plastic device for holding a gable-top milk carton during use.

Norton, Jerome H., and Taber, Russell E. **Container for maintaining temperature of bottled beverages.** U. S. pat. 2,979,227. Filed May 15, 1958. 2 claims. [Cl. 220-105.] A six-pack bottle carton is provided with means to hold ice about the bottles.

Opderbeck, Fritz, Trapp, Günther, and Wörner, Günter. **Method of producing viscose.** U. S. pat. 2,979,500. Filed May 13, 1958. 9 claims. Assigned to Phrix-Werke AF. [Cl. 260-217.] Aging of alkali cellulose is eliminated by treating the pulp with a cellulose-digesting enzyme.

Paschal, Don F. **Display mounts.** U. S. pat. 2,978,82- Filed April 8, 1959. 5 claims. [Cl. 40-210.] This is a paperboard desk mount for a calendar.

Pellaton, Ernest C., and Klapperich, Wilfred A. **Heat sealable carton and method of sealing same.** U. S. pat. 2,979,247. Filed May 27, 1957. 5 claims. Assigned to Fibreboard Paper Prods. Corp. [Cl. 229-14.] This is a lined frozen food carton.

Phillips, Wallace G., Hall, William O., and Overstreet, Henry H. **Container handle construction.** U. S. pat. 2,979,253. Filed Aug. 16, 1956. 3 claims. [Cl. 229-54.] A handle element is stitched into the end closure of a multi-ply paper bag.

Price, Robert G. **Apparatus for producing multi-pocket packages.** U. S. pat. 2,978,853. Filed Jan. 23, 1959. claims. Assigned to Thomas J. Lipton, Inc. [Cl. 53-178] This is a tea bag composed of two separable pouches.

Pritchard, Hugh E., and Shaltz, Gregory P. **Air filters.** U. S pat. 2,979,159. Filed Dec. 2, 1958. 1 claim. Assigned to Fram Corp. [Cl. 183-70.] The filter comprises a fiber batt surrounding a cylinder of porous pleated paper.

Ralph, Frederick W. **Web tension control.** U. S. pat. 2,979,280. Filed Dec. 10, 1958. 8 claims. Assigned to Witton-James, Ltd. [Cl. 242-75.42.]

Randall, Walter H., and Despres, Urban H. **Molded pulp carton.** U. S. pat. 2,979,245. Filed Sept. 25, 1957. 11 claims. Assigned to Keyes Fibre Co. [Cl. 229-2.5.] This is an egg carton with hinged cover.

Rinse, Jacobus. **Cyclic aluminum oxide acylates, alkoxides and phenoxides.** U. S. pat. 2,979,497. Filed Feb. 12, 1957. claims. Assigned to J. W. Ayers & Co. [Cl. 260-97.5.] These are waterproofing agents for paper.

Seegrist, Theodore A. **Laundry aids.** U. S. pat. 2,979,37 Filed May 13, 1955. (Divided; original filed Jan. 26, 1951.) claim. [Cl. 8-77.] Carboxymethyl cellulose is used.

Smith, Robert E. **Paper making apparatus.** U. S. pa 2,979,130. Filed Oct. 16, 1958. 1 claim. Assigned to Sandy Hill Iron and Brass Works. [Cl. 162-340.] A paper machine is provided with improved means to control the flow of stock on the forming wire.

Sweeney, John J. **Shaped articles of vinyl chloride resin and ethyl cellulose.** U. S. pat. 2,979,471. Filed Dec. 12, 1958. claims. Assigned to Okonite Co. [Cl. 260-17.]

Thompson, John S. **Solution and method of treating mica products and articles produced therefrom.** U. S. pat. 2,979,10 Filed Sept. 24, 1956. 11 claims. Assigned to Oxalloy C [Cl. 154-2.6.] Mica paper is treated with aluminum phosphate solution to improve wet strength.

Townsend, Headley T. **Sheet feeding machines.** U. S. pa 2,979,331. Filed July 2, 1958. 2 claims. [Cl. 271-46.]

Turner, Richard G. **Process for making non-woven fabric** U. S. pat. 2,978,786. Filed June 13, 1958. 3 claims. Assigned to Crompton & Knowles Corp. [Cl. 28-72.2.]

Vesak, Joseph. **Container carrier.** U. S. pat. 2,979,22 Filed Aug. 12, 1957. 4 claims. Assigned to Unipak Carton

Ltd. [Cl. 220-105.] This is a carrier carton for bottles or the like.

Washington, Harold. **Packaging of fragile articles.** U. S. pat. 2,979,248. Filed Oct. 15, 1959. 1 claim. Assigned to Washington Box, Ltd. [Cl. 229-14.] An interior packing member formed of corrugated board is provided.

Weber, Carl. **Sheet separating device.** U. S. pat. 2,979,330. Filed April 15, 1957. 16 claims. [Cl. 271-36.]

Wenzell, Louis P., Jr., and Lovin, Leak G., Jr. **Bonded batting, or non-woven fabric.** U. S. pat. 2,978,785. Filed March 5, 1956. 8 claims. Assigned to Celanese Corp. of Am. [Cl. 28-72.2.]

Wilson, Harry W. **Corrugating single facer.** U. S. pat. 2,979,112. Filed Sept. 9, 1957. 6 claims. [Cl. 154-31.]

April 18, 1961

Abbott, Horace P. **Carton board adhesion tester.** U. S. pat. 2,979,944. Filed Aug. 21, 1956. 4 claims. Assigned to Lever Bros. Co. [Cl. 73-150.]

Adams, Richard E. **Bag.** U. S. pat. 2,980,314. Filed July, 24, 1959. 1 claim. [Cl. 229-65.] A wire closure device is provided for a paper bag for packaging potatoes.

Amatel, Harold. **Article packing and dispensing carton.** U. S. pat. 2,980,240. Filed Sept. 24, 1958. 5 claims. Assigned to Westinghouse Elec. Corp. [Cl. 206-45.14.] This is a sleevelike carton for photoflash bulbs.

Arneson, Edwin L. **Collapsible tray.** U. S. pat. 2,980,310. Filed Sept. 30, 1959. 6 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 229-35.] This is a flat open-top tray with automatically locking corners.

Bardach, Martin, Field, Dale H., Gooden, Kenneth E., and Hood, William J. **Apparatus for applying insulating material about electrical devices.** U. S. pat. 2,980,565. Filed Aug. 15, 1957. 6 claims. Assigned to Hughes Aircraft Co. [Cl. 154-2.26.] Tape is applied to electrical components.

Baselt, Frederick C. **Container.** U. S. pat. 2,980,311. Filed Dec. 6, 1957. 2 claims. Assigned to American Can Co. [Cl. 229-37.] This is a flat-top paper container for milk.

Beese, William C. A., and Bergmann, Herbert E. **Non-stop winding of continuous web into successive rolls.** U. S. pat. 2,980,356. Filed Sept. 26, 1958. 6 claims. Assigned to Azon Corp. [Cl. 242-56.]

Belsinger, Samuel P. **Shipping container.** U. S. pat. 2,980,-239. Filed July 22, 1958. 5 claims. [Cl. 206-7.] This is a paperboard container for hangered garments.

Bergstein, Frank D., and Back, Leonard. **Apparatus for closing and sealing lined containers.** U. S. pat. 2,979,995. Filed Jan. 28, 1960. 27 claims. Assigned to Bergstein Pkg. Trust. [Cl. 93-44.]

Bolding, Hubert V. **Method of manufacture of box and structure thereof.** U. S. pat. 2,980,308. Filed March 8, 1957. 1 claim. Assigned to Standard Pkg. Corp. [Cl. 229-31.] A folding paperboard tray is provided.

Buttery, Kenneth T., and Vander Lugt, Thomas, Jr. **Carton.** U. S. pat. 2,980,316. Filed Nov. 9, 1959. 9 claims. Assigned to KVP Sutherland Paper Co. [Cl. 229-87.] This is a window carton for bacon slices.

Campbell, John, Jr. **Cyclone evaporator for residual liquor.** U. S. pat. 2,980,179. Filed June 25, 1954. 2 claims. Assigned to Babcock & Wilcox Co. [Cl. 159-4.] Black liquor is distributed on the walls of the evaporator so that a thin film of uniform thickness is formed.

Carr, Ralph L., and Dulany, Charles R. **Process for purifying spent mercerization caustic.** U. S. pat. 2,980,501. Filed Dec. 31, 1957. 8 claims. Assigned to Olin Mathieson Chem. Corp. [Cl. 23-49.]

Carter, Sidney T. **Bottle spotting apparatus for labeling machines.** U. S. pat. 2,980,278. Filed July 27, 1959. 23 claims. Assigned to Geo. J. Mayer Mfg. Co. [Cl. 216-13.]

Clifford, Burton K. **Ventilated honeycomb.** U. S. pat. 2,980,573. Filed May 7, 1959. 6 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 154-118.] The honeycomb is made of corrugated.

Cook, Wayne S., and Hormuth, Frank J. **Padding unit.** U. S. pat. 2,980,570. Filed Nov. 7, 1956. 10 claims. Assigned to Sackner Prods., Inc. [Cl. 154-53.6.] A fibrous batt wrapped and backed with paper is provided as upholstery padding.

de Grunigen, Alfred C. **Process for reducing anhydrous granulation of a medicinally active water-labile powder.** U. S. pat. 2,980,589. Filed Sept. 12, 1958. 10 claims. Assigned to Am. Cyanamid Co. [Cl. 167-82.] Ethyl cellulose is used as a binder.

Dempcy, Donald F., and Rule, Joseph M. **Process of impregnating paper with silica sols.** U. S. pat. 2,980,558. Filed May 29, 1958. 4 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-152.]

Donaldson, Robert M. **Rotary pressure vessels.** U. S. pat. 2,979,830. Filed Jan. 31, 1956. 12 claims. Assigned to Newport News Shipbuilding and Dry Dock Co. [Cl. 34-124.] A Yankee drier is constructed to permit the use of a shell of much greater thinness than usual.

Eastman, Howard W. **Tags.** U. S. pat. 2,979,840. Filed May 19, 1959. 2 claims. Assigned to Eastman Tag & Label Co. [Cl. 40-2.] A paperboard tag is provided with a plastic cover, rendering the tag weatherproof.

Etheridge, Oliver R. **Method of cooking starch.** U. S. pat. 2,980,576. Filed Jan. 30, 1958. (Divided; original filed Feb. 24, 1954.) 7 claims. Assigned to A. E. Staley Mfg. Co. [Cl. 162-175.] The process is for introducing starch at the wet end of the paper machine.

Fahrni, Fred. **Method and device for the formation of a stream of particles of constant layer thickness.** U. S. pat. 2,980,290. Filed Jan. 16, 1957. 21 claims. [Cl. 222-1.] A wood-particle board mat of uniform thickness is formed.

Galloway, Robert K. **Carton closing mechanism.** U. S. pat. 2,979,876. Filed Aug. 27, 1958. (Divided; original filed April 30, 1956.) 2 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 53-374.] The carton is closed and locked after insertion of a pie.

Galloway, Robert K. **Machine for inserting articles into cartons.** U. S. pat. 2,979,873. Filed March 11, 1959. (Divided; original filed April 30, 1956.) 4 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 53-251.] Cartons are erected, filled with pies, and end flaps are closed and locked.

Gentile, Anthony J., and Porter, Clemmon. **Non-fibrous regenerated cellulose film containing anchoring-plasticizing agent.** U. S. pat. 2,980,554. Filed Jan. 27, 1959. 15 claims. Assigned to Am. Cyanamid Co. [Cl. 117-76.]

Gould, William. **Shopping bag and handle structure therefor.** U. S. pat. 2,980,312. Filed Aug. 31, 1959. 4 claims [Cl. 229-54.]

Greene, Kermit. **Apparatus for applying flat strips to corrugated paper.** U. S. pat. 2,980,159. Filed Aug. 22, 1956. 1 claim. Assigned to Sherman Paper Prods. Corp. [Cl. 154-1.6.] Addition of paper strips to single-face corrugated permits vacuum feeding of blanks made from the corrugated.

Harrison, Raymond B., and Edwards, Russell G. **Sheet material for stiffening shoe uppers.** U. S. pat. 2,980,552. Filed Dec. 21, 1956. (Divided; original filed Nov. 16, 1953.) 6 claims. Assigned to Stedfast Rubber Co., Inc. [Cl. 117-68.] This material is an impregnated paper.

Hearden, Lester C., and Meyer, Ely. **Roll cutting device and the like.** U. S. pat. 2,979,979. Filed Jan. 16, 1956. 5 claims. Assigned to Sterling Pulp & Paper Co. [Cl. 83-407.] A mill roll of toilet paper is cut into small rolls without unrolling.

Howell, Chester E., Jr., and Taylor, Harwood S., Jr. **Box.** U. S. pat. 2,980,241. Filed Feb. 5, 1958. 11 claims. Assigned to F. M. Howell & Co. [Cl. 206-45.19.] This is a carton for silverware.

Kieckhefer, Herbert M. **Method of banding cardboard cartons.** U. S. pat. 2,979,871. Filed Jan. 7, 1957. 1 claim. Assigned to Weyerhaeuser Co. [Cl. 53-3.] A stack of collapsed cartons is compressed and banded together with a wide band of paper or the like.

Lambert, Charles M. **Gel-free rosin soap and method of preparing same.** U. S. pat. 2,980,629. Filed Sept. 13, 1957. 12 claims. Assigned to Hercules Powder Co. [Cl. 252-369.]

Le Gendre, Victor J. **Package.** U. S. pat. 2,980,244. Filed Dec. 3, 1957. 11 claims. Assigned to Burroughs Corp. [Cl. 206-46.] A folded strip of corrugated is used as interior packing in a radio tube package.

MacDonald, Norman A. **Method of packaging bacon.** U. S. pat. 2,980,541. Filed Sept. 29, 1958. 4 claims. Assigned to Luer Packing Co. [Cl. 99-174.] Bacon slices are packaged in a flat window carton.

Menzer, Alfred B. **Plastic sheet material.** U. S. pat. 2,980,-574. Filed May 28, 1956. 9 claims. Assigned to Kemlite Corp. [Cl. 154-128.] This is a decoratively printed laminate of glass and other fibrous sheets.

Miller, James S. **Open faced cartons for collapsible tubes.** U. S. pat. 2,980,242. Filed March 31, 1959. 9 claims. Assigned to Proctor & Gamble Co. [Cl. 206-45.31.] The item being packed is a toothpaste tube or the like.

Mills, Charles L., Jr. **Battery separators.** U. S. pat. 2,980,-750. Filed Feb. 26, 1959. 2 claims. Assigned to Monsanto Chem. Co. [Cl. 136-145.] The separator is a paper sheet impregnated with a phenol-formaldehyde resin containing a small portion of a polyelectrolyte.

Miner, Leonard P. **Envelope adapted to be routed to several destinations.** U. S. pat. 2,980,315. Filed March 16, 1959. 3 claims. Assigned to David E. Zimmer. [Cl. 229-73.] This is a message envelope containing an address plate of the magic erasing type.

Moss, Jack. **Business form assembly.** U. S. pat. 2,980,446. Filed March 18, 1957. 10 claims. [Cl. 282-22.]

Neumann, Gerhard M. **Filter element for extremely fine dust.** U. S. pat. 2,980,208. Filed May 21, 1957. 3 claims. Assigned to Delbag-Luftfilter G.m.b.H. [Cl. 183-71.] This is a folded paper element.

Paige, Richard E. **Carrier for containers.** U. S. pat. 2,980,249. Filed June 6, 1958. 5 claims. Assigned to Container Corp. of America. [Cl. 206-65.] This is a sleeve-type can carrier, such as a six-pack type.

Papas, Louis A. **Shadow box.** U. S. pat. 2,980,309. Filed Aug. 5, 1957. 6 claims. [Cl. 229-34.] The box, for use in advertising display, is formed of paperboard.

Petry, Robert K. **Resilient surface covering and process therefor.** U. S. pat. 2,980,575. Filed Oct. 18, 1957. 6 claims. Assigned to Congoleum-Nairn, Inc. [Cl. 154-138.] A floor covering of the decorative-surface, saturated-felt type is provided with a foam rubber backing.

Pick, Charles O. **Molded pulp tray dispenser.** U. S. pat. 2,980,289. Filed July 7, 1958. 3 claims. Assigned to Pacific Pulp Molding Co. [Cl. 221-279.] This apparatus is for use in dispensing molded pulp fruit packing trays.

Polovina, Walter. **Aluminum-containing non-leafing alkyd resin protective coating.** U. S. pat. 2,980,638. Filed June 17, 1957. 5 claims. Assigned to General Elec. Co. [Cl. 260-22.] Rosin is used.

Quinn, James L. **Bag.** U. S. pat. 2,980,313. Filed Sept. 23, 1957. 1 claim. Assigned to Bemis Bro. Bag Co. [Cl. 229-63.] A desiccant is packed in a bag formed of a nonwoven fabric.

Reider, Malcolm J. **Apparatus for providing long, soft vegetable fibers.** U. S. pat. 2,979,781. Filed July 27, 1959. (Divided; original filed April 28, 1954.) 6 claims. Assigned to Geo. W. Bollman & Co., Inc. [Cl. 19-7.] Fibers are recovered from ramie, kenaf, and the like.

Richer, Irving. **Hanger lock for garment shipping containers.** U. S. pat. 2,980,260. Filed May 31, 1960. 10 claims. [Cl. 211-124.]

Schneider, Kurt R. **Roll holder and web feeder.** U. S. pat. 2,980,359. Filed May 14, 1958. 16 claims. Assigned to Eureka Specialty Printing Co. [Cl. 242-75.3.] A strip of label-forming material is fed from a supply roll to a machine for labeling articles.

Schroeter, Gustav-Adolf. **Light sensitive layers of synthetic materials.** U. S. pat. 2,980,535. Filed Oct. 6, 1958. 5 claims. Assigned to Feldmühle Papierund Zellstoffwerke AG. [Cl. 96-35.] This is a photographic paper.

Segal, Leon, Loeb, Leopold, Takemura, Kazuo H., and Philips, Frederick J. **Textile fibers comprising perfluoroalkanoyl esters of cellulose and process of making the same.** U. S. pat. 2,980,491. Filed June 15, 1955. 9 claims. Assigned to U. S. Secretary of Agriculture. [Cl. 8-120.]

Sisco, Richard. **Paperboard fluid container.** U. S. pat. 2,980,304. Filed Feb. 15, 1958. 5 claims. [Cl. 222-566.] This is a paperboard milk carton which has a truncated pyramidal top and is closed with a snap-cap closure such as is used with glass bottles.

Sorensen, Roy T. **Loose leaf binder and supporting structure therefor.** U. S. pat. 2,980,445. Filed Sept. 18, 1958. 1 claim. [Cl. 281-33.] The structure supports the binder in erect open condition.

Stoker, Carl B., Jr. **Container, package, and manufacture of package.** U. S. pat. 2,980,245. Filed July 16, 1959. 2 claims. Assigned to Goodyear Tire & Rubber Co. [Cl. 206-46.] A plastic sheet is sealed over articles positioned on a paperboard backing.

Summerill, Robert J. **Printing paste for textile fabric.** U. S. pat. 2,980,487. Filed July 25, 1958. 6 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 8-70.] Pine oil and ethyl cellulose are used.

Thomsen, Donald L. **Method of making a heat-sensitive copy-sheet and resultant article.** U. S. pat. 2,980,551. Filed Feb. 13, 1959. 12 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-36.]

Tucci, Anthony. **Soap dispenser.** U. S. pat. 2,980,297. Filed Oct. 30, 1958. 3 claims. [Cl. 222-158.] A plastic dispenser is provided for attachment to a paperboard soup carton.

Turpin, Charles H. **Dough mix package.** U. S. pat. 2,980,540. Filed Dec. 12, 1958. 7 claims. Assigned to Pillsbury Co. [Cl. 99-172.] This is a compartmented carton within which the dough may be mixed with water.

Verrinder, Ernest A. **Method and apparatus for loading pallets.** U. S. pat. 2,979,872. Filed Sept. 28, 1956. 16 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 53-26.] A load of cartons is accumulated and placed on a pallet.

Weger, Ronald E. **Manifold violation and complaint form.** U. S. pat. 2,980,447. Filed Dec. 22, 1958. 1 claim. [Cl. 282-22.]

Wells, Roger. **Expandable transfer head for pulp molding machine.** U. S. pat. 2,980,183. Filed March 9, 1960. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 162-416.]

Welsch, Hans. **Assembly for pressing the upper end or lower margins of a container.** U. S. pat. 2,979,994. Filed Oct. 8, 1956. 8 claims. Assigned to Jagenberg-Werke A. G. [Cl. 93-36.]

Wiedemann, Eugen. **Method of wrapping windings of electric machines.** U. S. pat. 2,980,564. Filed Aug. 21, 1956. 4 claims. Assigned to AG Brown, Boveri & Cie. [Cl. 154-2.26.] The insulation used comprises mica plates secured within a folded paper tape.

Wohlfahrt, Otto, and Michel, Kurt. **Method for the production of high-voltage insulation, and insulation produced by this method.** U. S. pat. 2,980,566. Filed May 14, 1956. 1 claim. Assigned to AG Brown, Boveri & Cie. [Cl. 154-2.27.] Mica sewed to paper tape is used as the insulating material.

Zentner, Thomas G., and Boggs, Richard L. **Rotogravure printing of paperboard.** U. S. pat. 2,980,015. Filed June 6, 1956. 3 claims. Assigned to Diamond Natl. Corp. [Cl. 101-170.]

April 25, 1961

Anderson, John W. **Dispenser mounting.** U. S. pat. 2,981,442. Filed May 22, 1959. 10 claims. [Cl. 222-166.] Means are provided to mount a soap carton on a wall surface so that the carbon may be tilted to dispense the desired quantity.

Armstrong, James W., and Raforth, Bennie A. **Comestible package.** U. S. pat. 2,981,456. Filed Sept. 8, 1958. 2 claims. Assigned to Am. Can Co. [Cl. 229-16.] Ice cream is packaged in a container comprising an inner paperboard container with outer printed paper wrapper.

Arvidson, Bengt A. **Wrapping machine.** U. S. pat. 2,981,043. Filed Feb. 26, 1957. 6 claims. Assigned to Miller Wrapping & Sealing Machine Co. [Cl. 53-206.] The machine applies a wrapper to a tray or board holding slices of meat.

Azari, Eric. **Card processing apparatus.** U. S. pat. 2,981,41[illegible] Filed April 28, 1958. 22 claims. Assigned to Magnavox Co. [Cl. 209-72.] A machine for processing data cards is provided with means for transferring the cards from one conveying surface to another.

Baldwin, John P. **Container and spout therefor.** U. S. pat. 2,981,443. Filed Sept. 4, 1956. 4 claims. Assigned to Bar Line Dispensers, Inc. [Cl. 222-183.] A container for liquids includes an inner plastic bag and pouring spout and an outer paperboard carton.

Beachler, Edward D. **Suction box with changeable belt.** U. S. pat. 2,981,653. Filed Nov. 19, 1958. 12 claims. Assigned to Beloit Iron Works. [Cl. 162-200.]

Bennett, Harvey S. **Procedures and compositions for producing decorative effects.** U. S. pat. 2,981,632. Filed March 1, 1957. 2 claims. Assigned to Bloomfield Chem. Co., Inc. [Cl. 117-39.] Various cellulose derivatives are used in formulating a coating composition.

Clark, Alexander B., Jr. **Cloth reel.** U. S. pat. 2,981,40[illegible] Filed March 16, 1960. 2 claims. [Cl. 206-50.] A reel for bolts of cloth is formed of paperboard.

Cope, Paul E. **Carton.** U. S. pat. 2,981,455. Filed Dec. 1956. 10 claims. Assigned to Procter & Gamble Co. [Cl. 229-14.] A carton for flour or sugar or the like is provided with a carrying handle.

Davis, Warren F. **Shipping cartons for products subjected to inspection.** U. S. pat. 2,981,457. Filed Feb. 2, 1959. [illegible] claims. Assigned to Menasha Container of California. [Cl. 229-16.] This is a produce carton.

Dersch, Fritz, and De Angelus, Millet R. **Antifoggants and stabilizers for photographic silver halide emulsion.** U. S. pat. 2,981,624. Filed June 5, 1957. 6 claims. Assigned to General Aniline & Film Corp. [Cl. 96-109.] An antifogging layer is provided over the silver halide layer in photographic paper.

Flood, Carl A. **Indicia-applying apparatus.** U. S. pat. 2,981,432. Filed April 17, 1958. 12 claims. Assigned to Dennison Mfg. Co. [Cl. 216-2.] Labels are secured to a web of wrapping material.

Gamble, Charles B. **Dispenser for paper sheets.** U. S. pat. 2,981,408. Filed Feb. 6, 1959. 4 claims. [Cl. 206-73.]

Gaulke, Arthur W., and Hutchinson, Charles R. **Contour carton for wraparound windshields.** U. S. pat. 2,981,40[illegible] Filed Feb. 27, 1959. 8 claims. Assigned to Vanant Co., Inc. [Cl. 206-62.]

Geib, Clarence C., and Isaacson, Gilbert O. **Selenium rectifier.** U. S. pat. 2,981,872. Filed Aug. 20, 1953. 3 claims. Assigned to Fansteel Metallurgical Corp. [Cl. 317-234.] Polystyrene coated kraft paper is used in a rectifier.

Gentry, Hermond G. **Means for placing inserts between continuously traveling articles during packaging thereof.** U. S. pat. 2,981,042. Filed Aug. 21, 1958. 6 claims. Assigned to Mead Corp. [Cl. 53-157.] The inserts are placed between jars which are then unitized with a wrap-around paperboard blank.

Goyette, Francis H. **Sheet caliper control device for paper making.** U. S. pat. 2,981,175. Filed Nov. 6, 1957. 10 claims. Assigned to Lodding Eng. Corp. [Cl. 100-93.]

Grasty, William P. **Shipping and/or storing container.** U. S. pat. 2,981,405. Filed Sept. 20, 1957. 2 claims. Assigned to Abbott Labs. [Cl. 206-46.] A carton is provided for an empty or filled plastic blood bag and accessory equipment.

Harless, Charles A. **Printing machine folding mechanism.** U. S. pat. 2,981,540. Filed April 21, 1958. 9 claims. Assigned to R. Hoe & Co., Inc. [Cl. 270-77.]

Hartman, Owen A. **Inflammable container.** U. S. pat. 2,981,613. Filed Sept. 3, 1957. 4 claims. [Cl. 44-40.] Waxed board is used as a container for charcoal.

Hochner, Walter L., and Scarbrough, Abb L. **Cellulose treatment and product.** U. S. pat. 2,981,589. Filed May 21, 1958. 7 claims. Assigned to Natl. Lead Co. [Cl. 8-116.2.] The water repellency of paper and other cellulosic materials is improved.

Johanson, Karl L. **Piling machine for sheet-like materials.** U. S. pat. 2,981,420. Filed July 9, 1957. 8 claims. Assigned to Sven Leijonmarck. [Cl. 214-6.] Sheets of corrugated board are stacked.

Johnson, Oliver D. **Method for web feeding and cutting.** U. S. pat. 2,981,134. Filed Dec. 30, 1957. 2 claims. Assigned to Intern. Business Machines Corp. [Cl. 83-18.] An apparatus for cutting a paper web to form tabulator cards is provided with means to control card length.

Johnson, Richard H., and Kuehn, William G., Jr. **Granular material container with handle.** U. S. pat. 2,981,459. Filed Sept. 11, 1959. 1 claim. Assigned to Container Corp. of America. [Cl. 229-52.] A soap carton has an integral handle.

Justus, Edgar J. **Fluid floated belt for suction boxes.** U. S. pat. 2,981,329. Filed Nov. 3, 1958. 10 claims. Assigned to Beloit Iron Works. [Cl. 162-367.]

Justus, Edgar J. **Method and apparatus for reducing power required by moving suction box cover.** U. S. pat. 2,981,328. Filed Jan. 14, 1958. 5 claims. Assigned to Beloit Iron Works. [Cl. 162-367.]

Lodge, James R. **Color coated roofing granules and method of making the same.** U. S. pat. 2,981,635. Filed June 22, 1954. 14 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-62.]

Lodge, James R., Swenson, George W., and Reichel, Donald L. **Colored roofing granules.** U. S. pat. 2,981,636. Filed Feb. 18, 1957. 14 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-70.]

Mapes, Leslie A. **Automatic carton caser.** U. S. pat. 2,981,-040. Filed Feb. 20, 1959. 21 claims. [Cl. 53-62.] A machine is provided for casing paperboard milk cartons of a variety of sizes.

Martin, Eugene C., and Kelly, Joe T. **Organophosphorous-modified cellulose esters.** U. S. pat. 2,981,730. Filed Aug. 29, 1957. 9 claims. Assigned to Am. Oil Co. [Cl. 260-219.]

Miller, Robert E. **Cleaning sheet.** U. S. pat, 2,980,941. Filed Dec. 8, 1958. 8 claims. Assigned to The Natl. Cash Register Co. [Cl. 15-506.] This is paper provided with a coating containing pressure-rupturable capsules containing a liquid soil remover.

Olszowka, Edward P. **Dual air doctor for paper coating machines.** U. S. pat. 2,981,223. Filed March 31, 1960. 8 claims. Assigned to Howard Smith Paper Mills, Ltd. [Cl. 118-63.]

Paschal, Don F. **Display mount.** U. S. pat. 2,981,508. Filed May 11, 1959. 3 claims. [Cl. 248-35.] An easel-type paperboard mount for a desk calendar is provided.

Phelps, Richard W. **Adjustable mounting for air doctor.** U. S. pat. 2,981,224. Filed Jan. 13, 1958. 3 claims. Assigned to Black-Clawson Co. [Cl. 118-63.]

Pohl, Ernest F. **Tray package and method of packaging.** U. S. pat. 2,981,039. Filed Jan. 26, 1956. 2 claims. [Cl. 53-29.] The tray package holds a number of cups.

Rabins, Leonard. **Coil for electrical induction apparatus.** U. S. pat. 2,981,910. Filed Oct. 29, 1958. 9 claims. Assigned to General Elec. Co. [Cl. 336-58.] Paper is used as insulation.

Rupert, John P. **Cigarette.** U. S. pat. 2,981,261. Filed Feb. 9, 1959. 5 claims. [Cl. 131-9.] Cigarette paper is provided with porosity-increasing embossings.

Seragnoli, Ariosto. **Mechanism for feeding wrapping material to a wrapping machine.** U. S. pat. 2,981,541. Filed April 9, 1957. 1 claim. [Cl. 271-82.] Sheets of paper are cut from a supply roll and conveyed to a wrapping station.

Smith, Thomas R., and Jamieson, William. **Binder.** U. S. pat. 2,981,259. Filed July 18, 1958. 4 claims. [Cl. 129-40.] Paperboard and plastic elements form a binder for a number of magazines or the like.

Stickney, Wendell H., and Reifers, Richard F. **Pulp molding die.** U. S. pat. 2,981,330. Filed Dec. 20, 1956. 9 claims. Assigned to Diamond Natl. Corp. [Cl. 162-411.]

Thibault, George E. **Cardboard box with a carrying handle.** U. S. pat. 2,981,458. Filed Dec. 31, 1958. 2 claims. Assigned to Charles W. Stampler. [Cl. 229-52.]

Vollans, Maurice H. **Clamping tool.** U. S. pat. 2,980,913. Filed Sept. 17, 1958. 1 claim. [Cl. 1-260.] Carton flaps are supported so that they may be stapled.

Walton, Selwyn R. **High explosive filler for naval underwater munitions.** U. S. pat. 2,981,618. Filed May 6, 1952. 3 claims. Assigned to U. S. Secretary of the Navy. [Cl. 52-6.] Cellulose nitrate is used in a desensitizer composition.

Williamson, William A. **Paper roll handling truck.** U. S. pat. 2,981,429. Filed March 26, 1959. 16 claims. Assigned to Clark Equipment Co. [Cl. 214-654.]

May 2, 1961

André, Noble. **Multi-can carrier and package.** U. S. pat 2,982,400. Filed April 7, 1958. 3 claims. Assigned to Andre-Matic Machinery Co. [Cl. 206-65.]

Azari, Eric, Gray, Alfred E., Malin, Herman J., Nelson, Alfred M., and Thompson, Harold B. **Card processing apparatus.** U. S. pat. 2,982,544. Filed Feb. 18, 1958. 11 claims. Assigned to The Magnavox Co. [Cl. 271-5.] Means are provided to transfer data cards from a conveying medium into a holding station.

Boyd, Harry S. **Backing strips for printing presses.** U. S. pat. 2,982,208. Filed Dec. 6, 1957. 3 claims. [Cl. 101-407.] The strip permits cutting or perforating on a platen press during the printing operation.

Carew, Herman. **Bulk container.** U. S. pat. 2,982,459. Filed July 14, 1955. 1 claim. Assigned to Am. Can Co. [Cl. 229-5.5.] A round nesting paper container with cover is provided for packaging ice cream and the like.

Coleman, Walter W., and Cook, George W. **Banding machine and method.** U. S. pat. 2,982,063. Filed Feb. 20, 1958. 8 claims. Assigned to Reed Research, Inc. [Cl. 53-3.] A stack of filled envelopes is banded together by cellophane tape.

Collins, Edgar F. **Cartons.** U. S. pat. 2,982,463. Filed June 20, 1958. 2 claims. Assigned to Metal Edge Inds. (Inc.). [Cl. 229-35.] The cartons have fully telescoping body and cover sections the side and end walls of which are held in place by interlocking means.

Colwill, Richard H. **Collator.** U. S. pat. 2,982,542. Filed Nov. 6, 1956. 14 claims. Assigned to Farrington Business Machines Corp. [Cl. 270–58.]

Cooley, Robert A., and Bruson, Herman A. **Nitrocellulose propellants containing lead salts of aliphatic acids.** U. S. pat. 2,982,638. Filed Oct. 12, 1956. 10 claims. Assigned to Olin-Mathieson Chem. Corp. [Cl. 52-5.]

Cooper, Francis H., and Tew, Gilbert W. **Longitudinal seam sealer.** U. S. pat. 2,982,334. Filed April 24, 1959. 18 claims. Assigned to Sperry Rand Corp. [Cl. 154-42.] This machine is for use in forming and filling bags from a continuous web of material.

Curler, Howard J., and Bauer, Richard M. **Machine for manufacture of glossy coated sheets.** U. S. pat. 2,982,245. Filed April 10, 1959. (Divided; original filed Oct. 2, 1956.) 6 claims. Assigned to Am. Can Co. [Cl. 118-69.] Glossy wax-coated carton blanks are formed.

Curtis, Donald W. **Double-disk refiner.** U. S. pat. 2,982,-482. Filed June 1, 1960. 4 claims. Assigned to E. D. Jones Corp. [Cl. 241-33.] Pressure on opposite sides of the rotating disks is automatically equalized.

Dakin, Vernon W. **Packaging machine.** U. S. pat. 2,982,067. Filed June 23, 1958. 3 claims. Assigned to General Motors Corp. [Cl. 53-180.] Articles are placed in pockets formed in a plastic strip, a backing material is sealed over the open sides of the pockets, and the completed packs are cut apart.

Ellis, Asher R., and Broughton, Carl L. **Cellulosic product.** U. S. pat. 2,982,680. Filed April 18, 1960. 5 claims. Assigned to Kimberly-Clark Corp. [Cl. 154-46.] A wall covering or the like comprises a laminate of paper, nonwoven synthetic filament scrim, and creped wadding.

Endo, Minoru T. **Card processing apparatus.** U. S. pat. 2,982,546. Filed March 12, 1956. 8 claims. Assigned to The Magnavox Co. [Cl. 271-71.] Means are provided to transfer data cards from a drum carrying the cards to one of two output stacks.

England, Victor. **Strapping device and method.** U. S. pat. 2,982,069. Filed April 21, 1958. 9 claims. [Cl. 53-198.] A material for banding articles together comprises a strip formed of a number of parallel strands of twisted paper cord.

Fallert, Clifford D. **6-Cornered glued box with cover lock.** U. S. pat. 2,982,465. Filed March 5, 1958. 5 claims. Assigned to Crown Zellerbach Corp. [Cl. 229-36.]

Fisher, John V. **Multiple container package and carrier device.** U. S. pat. 2,982,399. Filed April 29, 1957. 15 claims. Assigned 20% to Larry Crosby and 20% to Kenneth M. Crawford. [Cl. 206-65.] This is a six-pack can carrier.

Foster, Forrest K. **Carton opening device.** U. S. pat. 2,982,075. Filed Dec. 17, 1959. 12 claims. Assigned to Revenue Stamp Co. [Cl. 52-381.] Cigarette cartons are opened for affixing revenue stamps.

Gancberg, Abraham. **Process to render water-repellent building materials.** U. S. pat. 2,982,674. Filed Nov. 30, 1956. 1 claim. Assigned to Union Chimique Belge, S. A. [Cl. 117-123.] The building materials include asbestos-cement board and the like.

Giles, William H., and Frank, Anton R. **Machine for assembling, securing, and banding packages.** U. S. pat. 2,982,065. Filed Aug. 27, 1958. 8 claims. Assigned to Van Buren Machine Corp. [Cl. 53-159.] Wrapped bars of soap are adhesively joined together and then banded.

Grun, Hans-Hellmut, and Schmidt, Joachim. **Process for continuously admixing alkali cellulose with etherifying agents.** U. S. pat. 2,982,765. Filed June 23, 1958. 7 claims. Assigned to Henkel & Cie. G.m.b.H. [Cl. 260-231.]

Hauptmann, Vinzenz. **Reinforcing joint for a container.** U. S. pat. 2,982,460. Filed Oct. 8, 1957. 1 claim. Assigned to Mauser Kommandit-Gesselschaft. [Cl. 229-5.6.] The joint is between one metal wall and one paperboard wall.

Hennion, Joseph B. **Carton.** U. S. pat. 2,982,458. Filed Feb. 26, 1958. 2 claims. Assigned to Tyler Refrigeration Corp. [Cl. 229-4.5.] This is a paper milk carton having a central section of reduced cross section between upper and lower frustoconical portions.

Hopkinson, David B. **Automatic carton sealing apparatus.** U. S. pat. 2,982,064. Filed Oct. 14, 1959. 9 claims. Assigned to Southworth Machine Co. [Cl. 53-76.] A large carton containing a ream of paper sheets is vacuum sealed.

Hultin, Oscar H. **Package.** U. S. pat. 2,982,461. Filed March 10, 1955. 10 claims. Assigned to Pneumatic Scale Corp., Ltd. [Cl. 229-17.] A pouring spout construction is provided in a lined carton.

Kapral, Ales M. **Method of water- and grease-proofing paper products.** U. S. pat. 2,982,675. Filed May 8, 1956. 13 claims. Assigned to Process Methods Corp. [Cl. 117-154.]

Krummel, Frederick J. **Pulp stock valves.** U. S. pat. 2,982,513. Filed Oct. 24, 1957. 2 claims. Assigned to Walworth Co. [Cl. 251-203.]

Little, John R. **Wax-impregnated corrugated paperboard construction and method for manufacturing was impregnated corrugated paperboard.** U. S. pat. 2,982,333. Filed Jan. 7, 1959. 6 claims. Assigned to West Virginia Pulp & Paper Co. [Cl. 154-33.05.]

Lyon, Floyd A., and Aronson, Theodore F. **Article wrapping and sealing means.** U. S. pat. 2,982,070. Filed July 23, 1957. 1 claim. [Cl. 53-206.] Wrapping paper is sealed about men's socks mounted on a piece of paperboard.

McKeen, Joseph E. **Apparatus for making perforated sheet material.** U. S. pat. 2,982,186. Filed May 9, 1956. 1 claim. Assigned to Micro-Vent, Inc. [Cl. 93-1.] Spark electrodes are used to perforate paper, as in the manufacture of wallboard joint tape.

Makrauer, Irvin. **Garment bag dispensing unit.** U. S. pat. 2,982,398. Filed April 18, 1958. 6 claims. Assigned to Sydney Thomas Corp. [Cl. 206-57.] A paperboard device holds several plastic garment bags which may be withdrawn singly for use.

Matlin, Nathaniel A., and Kine, Benjamin B. **Non-woven bonded fibrous products and methods for their production.** U. S. pat. 2,982,682. Filed Aug. 13, 1956. 8 claims. Assigned to Rohm & Haas Co. [Cl. 154-101.]

Mestre, Luis. **Sheet gaging and detecting device.** U. S. pat. 2,982,545. Filed Oct. 1, 1959. (Divided; original filed Nov. 26, 1957.) 12 claims. [Cl. 271-57.] Paper sheets being fed to a printing or other machine are gaged for thickness and the machine stopped if two sheets are being fed together.

Morton, David C., and Packman, Percival J. **Packaging apparatus.** U. S. pat. 2,982,078. Filed June 9, 1959. 10 claims. Assigned to Forgrove Machinery Co., Ltd. [Cl. 53-390.] Glassine cups are filled with candy and then cartoned.

Moser, Rudolf. **Apparatus for folding paper webs in rotary machines.** U. S. pat. 2,982,543. Filed Dec. 30, 1957. 2 claims. Assigned to Ringier & Co. A. G. [Cl. 270-60.]

Naidus, Edward S., and Betts, Leonard F. **Method of coating articles of food and composition therefor.** U. S. pat. 2,982,658. Filed April 11, 1957. 9 claims. Assigned to Wasco Chem. Co., Inc. [Cl. 99-166.] Ethyl cellulose is used.

Pape, Henry C., and Peterson, Victor A. **Shade roller packaging apparatus.** U. S. pat. 2,982,068. Filed June 12, 1958. 26 claims. Assigned to Slick Airways, Inc. [Cl. 53-186.]

Reinhardt, Charles M. **Nitrocellulose.** U. S. pat. 2,982,643. Filed July 23, 1958. 1 claim. Assigned to Olin Mathieson Chem. Corp. [Cl. 52-20.] Solid globules of cellulose nitrate are formed.

Renne, William C. **Wallpaper trimming and pasting machine.** U. S. pat. 2,982,490. Filed Dec. 17, 1956. 5 claims. [Cl. 242-56.2.]

Sharp, Andrew, Butterfill, Sydney T., and Campbell, Douglas J. **Combination reinforced box.** U. S. pat. 2,982,462. Filed Oct. 30, 1957. 1 claim. Assigned to Bathurst Power & Paper Co., Ltd. [Cl. 229-23.] A shipping container comprises a wire-bound corrugated box reinforced with a wood frame.

Shelton, William E. **Flap unfolding device.** U. S. pat. 2,982,076. Filed Dec. 17, 1959. 8 claims. Assigned to Revenue Stamp Co. [Cl. 53-381.] Cigarette cartons are opened for affixing revenue stamps.

Shields, Albert F. **Power driven adjusting means for slotting, scoring, creasing and slitting machine.** U. S. pat. 2,982,189. Filed Sept. 6, 1957. 5 claims. Assigned to S & S Corrugated Paper Machinery Co., Inc. [Cl. 93-49.]

Shiu, Thomas B. **Closing and sealing mechanism.** U. S. pat. 2,982,074. Filed Aug. 13, 1957. 12 claims. Assigned 25% to Nicholas A. Cummings, 25% to Thomas N. Cummings, and 25% to Benjamin R. Peterson, Jr. [Cl. 53-373.] A heat-sealed closure is formed on a paper cup containing an ice cream cone.

Smith, John W. **Wrapper feeding mechanism for wrapping machines adapted to handle limp films.** U. S. pat. 2,982,077. Filed Oct. 1, 1959. 16 claims. Assigned to Battle Creek Pkg. Machines, Inc. [Cl. 53-389.]

Stelling, Walter R., Jr. **Bag making machine.** U. S. pat. 2,982,187. Filed June 12, 1958. 10 claims. Assigned to Faustel, Inc. [Cl. 93-8.]

Thompson, William, Jr. **Packaging apparatus.** U. S. pat. 2,982,066. Filed June 25, 1956. 18 claims. Assigned to Roto Wrap Machine Co. [Cl. 53-180.] Articles are sealed between two webs of packaging material and the assembly is cut apart to provide individual packages.

Vegeby, Anders U. I. **Combustion of waste liquors.** U. S. pat. 2,982,606. Filed March 14, 1956. 5 claims. Assigned to Aktiebolaget Götaverken. [Cl. 23-48.] Improved means are provided for supplying air of combustion to a black liquor furnace.

von Hofe, George W., and Spano, John F. **Box making machines.** U. S. pat. 2,982,188. Filed April 26, 1957. 88 claims. Assigned to New Jersey Machine Corp. [Cl. 93-41.] A flat open-box is erected and corner stay strips applied thereto.

Wetzel, Wilfred W., and Schlater, Harry A. **Method for testing gummed tape.** U. S. pat. 2,982,129. Filed Nov. 12, 1954. 5 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 73-150.] The shear strength of gummed tape is measured.

Williams, John L. **Stock valve having non-clog gate blade.** U. S. pat. 2,982,295. Filed June 10, 1957. 3 claims. [Cl. 137-242.]

Wingate, John L. **Folding box.** U. S. pat. 2,982,464. Filed Aug. 25, 1958. 6 claims. [Cl. 229-35.] An improved corner interlocking arrangement is provided.

Wolfe, Edgar H. **Upright display binder.** U. S. pat. 2,982,568. Filed Aug. 18, 1958. 5 claims. Assigned to The Barrett Bindery Co. [Cl. 281-33.]

Zimmerer, Mark E. **Folding machine.** U. S. pat. 2,982,073. Filed June 23, 1958. 11 claims. Assigned to Kingston Products Corp. [Cl. 53-366.] The lid of an egg carton is applied to the body.

May 9, 1961

Aaron, Charles, and Rockstrom, Leonard. **Apparatus for controlling the tension in a running web.** U. S. pat. 2,983,467. Filed March 21, 1957. 4 claims. Assigned to Cameron Machine Co. [Cl. 242-75.43.]

Amatel, Harold, and Sanford, Stuart P. **Lamp container.** U. S. pat. 2,983,372. Filed March 6, 1958. 5 claims. Assigned to Westinghouse Elec. Corp. [Cl. 206-65.] A windowed partitioned carton is provided for several flashbulbs.

Anderson, Bryce P. **Treating a cellulose-containing base to impart thereto acid resistance, composition therefor and the resultant product.** U. S. pat. 2,983,629. Filed June 13, 1958. 19 claims. Assigned to De Soto Chem. Coatings, Inc. [Cl. 117-148.] This is similar to U. S. pat 2,983,630 (May 9, 1961).

Anderson, Bryce P. **Treating a cellulose-containing base to impart thereto alkali resistance, composition therefor and the resultant product.** U. S. pat. 2,983,630. Filed Aug. 25, 1958. 19 claims. Assigned to De Soto Chem. Coatings, Inc. [Cl. 117-148.] The base may be paper or other cellulosic material.

Arneson, Edwin L. **Article carrier.** U. S. pat. 2,983,401. Filed April 4, 1958. 2 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 220-105.] This is a six-pack bottle carrier.

Azari, Eric, Malin, Herman J., and Orner, Allan. **Card processing apparatus.** U. S. pat. 2,983,507. Filed Sept. 2, 1958. 16 claims. Assigned to Magnavox Co. [Cl. 271-5.] A reversible card feeder-stacker is provided for a machine for processing data cards.

Bergstein, Frank D. **Closure means for liquid tight cartons.** U. S. pat. 2,983,419. Filed March 10, 1953. 2 claims. Assigned to The Bergstein Pkg. Trust. [Cl. 229-7.] An improved hinged plug-type closure is provided in a flat-top milk carton.

Bergstein, Robert M. **Two-piece self-locking carrying box.** U. S. pat. 2,983,429. Filed Dec. 27, 1957. 2 claims. Assigned to Bergstein Pkg. Trust. [Cl. 229-45.]

Bess, Henry F. **Carton.** U. S. pat. 2,983,428. Filed March 6, 1959. 2 claims. Assigned to Weyerhaeuser Co. [Cl. 299-34.] A cigar box is formed entirely of paperboard.

Birr, Rudolph G. **Paper roll slotting machine.** U. S. pat. 2,983,200. Filed June 5, 1957. 1 claim. Assigned to Stein Am. Corp. [Cl. 90-21.] Slots are cut in the end of a roll of paper towels so that the roll may be fitted in a dispenser.

Biskup, John, Johnson, Spencer, and Wetterau, Paul

Process for producing decorative surface covering. U. S. pat. 2,983,622. Filed July 22, 1958. 5 claims. Assigned to Congoleum-Nairn, Inc. [Cl. 117-15.] An asphalt-impregnated cellulose backing material is provided.

Camilli, Concetto T. **Microcrystalline wax.** U. S. pat. 2,983,664. Filed July 24, 1958. 12 claims. Assigned to Esso Research and Eng. Co. [Cl. 208-20.] This is a wax for coating and laminating paper.

Cella, Joseph F., and Gancia, Paul. **Bottle packaging machine.** U. S. pat. 2,983,596. Filed April 20, 1959. (Divided; original filed May 19, 1954.) 5 claims. Assigned to Cella Machinery, Inc. [Cl. 53-26.] Bottles are cased.

Coates, Harold. **Flame proofing agents derived from methylol phosphorus polymers.** U. S. pat. 2,983,623. Filed Dec. 1, 1959. 10 claims. Assigned to Albright & Willson, Ltd. [Cl. 117-62.] These are for flameproofing paper or the like.

Cram, Hervey G. **Cylindrical paper stock screen.** U. S. pat. 2,983,379. Filed March 17, 1958. 7 claims. Assigned to Combined Locks Paper Co. [Cl. 209-273.]

Dalton, Harold R. **Electrochemical recording.** U. S. pat. 2,983,654. Filed Sept. 30, 1958. 6 claims. Assigned to Timefax Corp. [Cl. 204-2.] An electrolytic recording paper is prepared.

Dalton, Harold R., and Wolf, Murray. **Electro-sensitive planographic printing plate.** U. S. pat. 2,983,220. Filed March 16, 1955. 7 claims. Assigned to Timefax Corp. [Cl. 101-149.2] This is a paper-base product.

Dick, George M. **Feed conveyor for a log debarker.** U. S. pat. 2,983,291. Filed Jan. 22, 1957. 5 claims. Assigned to Canadian Ingersoll-Rand Co., Ltd. [Cl. 144-242.]

Duke, Bruce W. **Adhesive compositions and products.** U. S. pat. 2,983,593. Filed March 2, 1959. 7 claims. Assigned to Norton Co. [Cl. 51-298.] The adhesive is used in the preparation of a paper-base abrasive sheet.

Elling, Hugo, Elssner, Richard, Grotjahn, Heinz, and Heuer, Kurt. **Manufacture of viscose rayon.** U. S. pat. 2,983,572. Filed June 6, 1958. 7 claims. Assigned to Am. Enka Corp. [Cl. 18-54.] The coagulation modifier is a mixture of an ethoxylated amine and polyethylene glycol.

Engleson, Harry E., and Sramek, Elmer D. **Orientation and transfer apparatus for wrapping machine.** U. S. pat. 2,983,092. Filed May 1, 1959. 14 claims. Assigned to Crompton & Knowles Pkg. Corp. [Cl. 53-133.]

Flannery, Edward J. **Speed-matching system for printing press paster apparatus.** U. S. pat. 2,983,458. Filed July 2, 1956. 5 claims. Assigned to R. Hoe & Co. [Cl. 242-58.3.] This is an automatic roll-change apparatus for a web-fed printing press.

Fouillet, Claude A. M. **Calenders.** U. S. pat. 2,983,020. Filed July 18, 1957. 1 claim. Assigned to Productos Mexalit, S. A. [Cl. 25-30.] Improved calendering means are provided in a machine for making asbestos-cement tubing.

Frickert, Philip J. **Strand packaging apparatus.** U. S. pat. 2,983,025. Filed Aug. 26, 1958. 8 claims. Assigned to Owens-Corning Fiberglas Corp. [Cl. 28-21.] Strands of glass fiber are wound into the interior of a packaging container.

Fuller, Charles E. **Tensioning device for printing presses.** U. S. pat. 2,983,464. Filed March 27, 1959. 8 claims. [Cl. 242-75.44.]

Galbraith, Martin J., and Burbank, Wendell T. **Machine for testing perforations in tear open cartons.** U. S. pat. 2,983,139. Filed Feb. 24, 1959. 8 claims. Assigned to KVP Sutherland Paper Corp. [Cl. 73-102.]

Glaser, Jules. **Packing.** U. S. pat. 2,983,427. Filed Oct. 21, 1958. 4 claims. Assigned to Max Lehner-Stirnemann. [Cl. 229-28.] A tubular compartmented carton for eggs or the like is provided.

Glass, Harold L. **Multiple compartment box.** U. S. pat. 2,983,424. Filed May 28, 1957. 2 claims. [Cl. 229-27.] A cigarette box includes two separately openable compartments.

Gray, Willard F. M., and Hurt, William C., Jr. **Method and apparatus for winding coils of web material.** U. S. pat. 2,983,459. Filed Jan. 20, 1958. 9 claims. Assigned to General Elec. Co. [Cl. 242-67.3.] Kraft paper is wound with foil in the production of an electrical coil.

Kehoe, James W. **Tab set with framed card.** U. S. pat. 2,983,524. Filed March 9, 1959. 2 claims. Assigned to Shelby Salesbook Co. [Cl. 282-22.] A manifold set includes a tabulating card, copy sheets, and carbon paper.

Klausmann, Milton H., and Von Culin, Raymond P. **Combined container and foil pouring spout.** U. S. pat. 2,983,410. Filed Oct. 9, 1958. 2 claims. Assigned to Seal-Spout Corp. [Cl. 222-532.]

Knoll, Henry L., Holland, Kenneth M., and Steele, Roger C. **Method of making honeycomb.** U. S. pat. 2,983,640. Filed June 24, 1957. 7 claims. Assigned to Hexcel Prods., Inc. [Cl. 154-122.] An expansible paper honeycomb material is made.

Levi, Hans L. **Drinking straw and method of manufacture.** U. S. pat. 2,983,616. Filed June 30, 1960. 14 claims. [Cl. 99-138.] This is a flavored straw made of paper and cellophane.

Mercur, Dave. **Snap-out envelopes.** U. S. pat. 2,983,525. Filed May 16, 1958. 4 claims. [Cl. 282-25.] This is an envelope for receiving and shipping photographic materials for finishing.

Miller, Otto M., Jr. **Pouring spout construction.** U. S. pat. 2,983,422. Filed Sept. 22, 1958. 3 claims. Assigned to Continental Can Co., Inc. [Cl. 229-17.] The construction is provided in a carton.

Mueller, Allen L. **One piece collapsible partitioned carton.** U. S. pat. 2,983,426. Filed Dec. 11, 1957. 1 claim. Assigned to Burd & Fletcher Co. [Cl. 229-28.] This carton is for shipping cartridges.

Nerney, Francis X., Easton, Bernard K., and Weinberg, Norbert. **Bleaching peroxide impregnated cellulosic fabrics by contact with a dry heated body.** U. S. pat. 2,983,568. Filed Aug. 18, 1958. 5 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 8-111.]

Newland, Gordon C., and Tamblyn, John W. **Cellulose organic ester compositions stabilized with a synergistic mixture of copper stearate and paratertiarybutyl phenol.** U. S. pat. 2,983,621. Filed June 19, 1959. 2 claims. Assigned to Eastman Kodak Co. [Cl. 106-171.]

Patterson, Charles R. **Automatic pasting machine for paper sheets or the like.** U. S. pat. 2,982,979. Filed May 11, 1959. 13 claims. [Cl. 11-1.] The edges of two or more sheets of paper are adhered together as in the manufacture of manifold sets.

Rellstab, George C. **Carton.** U. S. pat. 2,983,420. Filed June 26, 1959. 6 claims. Assigned to E. F. Dodge Paper Box Corp. [Cl. 229-16.] The carton is filled as a tray, but after closing may be reopened and reclosed as a tube.

Richards, Gerald V. **Display carton.** U. S. pat. 2,983,371. Filed Feb. 12, 1958. 1 claim. Assigned to Container Corp. of Am. [Cl. 206-65.] A sleeve-and-drawer carton is provided for packaging tumblers.

Rodriguez, Manuel G. **Egg carton with advertising means.** U. S. pat. 2,983,425. Filed July 23, 1957. 13 claims. [Cl. 229-28.]

Runton, Leslie A. **Laminated non-woven belt.** U. S. pat. 2,983,636. Filed Jan. 16, 1957. 3 claims. Assigned to Russell Mfg. Co. [Cl. 154-52.1.] Paper is used in the construction of a laminated conveyor belt.

Schappel, Joseph W. **Treatment of silica coated fibers.** U. S. pat. 2,983,625. Filed Feb. 20, 1957. 18 claims. Assigned to Am. Viscose Corp. [Cl. 117-76.] Improved retention of silica and improved fiber properties are provided in a process for coating cellulose fibers with silica.

Seiberling, Theophilus K. **Rubber lamina, with surface adapted to be adhered to another surface by adhesive.** U. S. pat. 2,983,643. Filed April 7, 1958. 3 claims. Assigned to Seiberling Rubber Co. [Cl. 154-139.] A product for use in shoe making comprises rubber laminated to paper.

Stein, Jesse. **Articles for puncturing small apertures in cigarettes and the like.** U. S. pat. 2,983,044. Filed Nov. 4, 1959. 1 claim. [Cl. 30-123.] Vent holes are formed in a cigarette wrapper by a wire device in a paper matchbook.

Stoeckel, Albert L., and Zimmermann, Carl T. **Packaging machine.** U. S. pat. 2,983,088. Filed Dec. 21, 1956. 11 claims. Assigned to U. S. Steel Corp. [Cl. 53-59.] A machine for packaging nails is provided with means to prevent entangling of the nails during the packaging process.

Taperell, Geoffrey L. **Machine for manipulating sheets or webs of stationery.** U. S. pat. 2,983,355. Filed Nov. 21, 1957. 7 claims. Assigned to W. H. Smith & Son (Alcara), Ltd. [Cl. 197-133.] The sheets or webs are moved past the printing station of a business machine.

Taylor, Donald B. **Multi-wall bag and the like.** U. S. pat. 2,983,430. Filed March 21, 1957. 5 claims. Assigned to Hudson Pulp & Paper Corp. [Cl. 229-66.]

Turan, Nathaniel. **Return mailing piece folder.** U. S. pat. 2,983,431. Filed July 18, 1958. 4 claims. [Cl. 229-92.3.]

Turpin, Charles H. **Compartmented carton.** U. S. pat. 2,983,421. Filed July 13, 1960. 3 claims. Assigned to the Pillsbury Co. [Cl. 229-17.]

Vail, Robert F. **Self-locking shipping container.** U. S. pat. 2,983,423. Filed Oct. 20, 1960. 8 claims. Assigned to Massillon Container Co. [Cl. 229-23.] This container is for shipping relatively heavy products.

Vander Lugt, Thomas, Jr. **Display device.** U. S. pat. 2,983,368. Filed Dec. 22, 1959. 12 claims. Assigned to KVP Sutherland Paper Co. [Cl. 206-45.14.] A paperboard display stand is provided for supporting a flash-light and batteries.

Wallace, Charles A., Risko, Henry L., and El-Hindi, Ahmad M. **Liquid filter.** U. S. pat. 2,983,383. Filed Oct. 22, 1956. 2 claims. Assigned to United States Hoffman Machinery Corp. [Cl. 210-97.] Paper is used as the filtering medium in filtering coolant liquid from grinders, hones, and the like.

Williams, Harold M. G. **Methods of making webs of fibrous material.** U. S. pat. 2,983,627. Filed Aug. 22, 1957. 8 claims.

Assigned to Portals, Ltd. [Cl. 117-138.8.] Synthetic fiber paper is formed.

Winkler, Richard, and Dünnebier, Kurt. **Method of and apparatus for making envelopes.** U. S. pat. 2,983,201. Filed Jan. 24, 1958. 22 claims. Assigned to Berkley Machine Co. [Cl. 93-62.]

May 16, 1961

Arneson, Edwin L. **Article carrier.** U. S. pat. 2,984,383. Filed Oct. 28, 1959. 6 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 220-113.] This is a six-pack bottle carrier.

Bagnall, John. **Apparatus for the manufacture of handle attachments for paper bags.** U. S. pat. 2,983,921. Filed July 28, 1958. 3 claims. Assigned to Canada Paper Co. [Cl. 1-2.]

Billeter, Henry R. **Book handling mechanism.** U. S. pat. 2,984,330. Filed Feb. 4, 1960. 6 claims. Assigned to R. R. Donnelley & Sons Co. [Cl. 198-20.] Unbound books are conveyed into a bookbinding machine.

Brisley, Frank O., and Gambill, Ulysses T. **Acoustical wall board.** U. S. pat. 2,984,312. Filed April 24, 1959. 17 claims. Assigned to Owens-Corning Fiberglas Corp. [Cl. 181-33.]

Carmichael, Hoagland H. **Cigarette package.** U. S. pat. 2,984,340. Filed Feb. 19, 1959. 1 claim. Assigned to Robert H. Eckhoff. [Cl. 206-41.] The package is for cigarettes that are only half as long as the conventional type.

Catlett, Richard H., and Fitzpatrick, Robert F. **Package holder.** U. S. pat. 2,984,395. Filed June 15, 1959. 2 claims. [Cl. 225-42.] A wall-mounted apparatus is provided for housing and dispensing paper or the like from a supply roll.

Chalmers, John W., and Jackson, Donald R. P. **Wrapping for cigarettes.** U. S. pat. 2,984,384. Filed Feb. 19, 1959. (Divided; original filed Sept. 11, 1956.) 1 claim. Assigned to Molins Machine Co., Ltd. [Cl. 221-31.] A pull-tab ejector is included in a cigarette pack.

Cook, John M., Charbonnier, James W., and Staunton, Le Roy. **Manufacture of carton blanks.** U. S. pat. 2,984,161. Filed July 7, 1953. 2 claims. Assigned to United Wallpaper, Inc. [Cl. 93-36.]

David, Andrew M. **Two in one bank deposit envelope.** U. S. pat. 2,984,403. Filed Aug. 10, 1959. 1 claim. [Cl. 229-73.]

Emery, Richard L. **Packing for fragile articles.** U. S. pat. 2,984,345. Filed Aug. 2, 1957. 3 claims. Assigned to Keyes Fibre Co. [Cl. 206-65.] Molded pulp packing elements are provided for use in packaging fluorescent light tubes or the like.

Fienup, William F. J., and Galbierz, Jerome J. **Shotgun shell tube or cartridge.** U. S. pat. 2,984,182. Filed March 3, 1958. 7 claims. Assigned to R. C. Can Co. [Cl. 102-42.] The tube is formed of paper strips.

Gadiel, Peter. **Tape dispenser.** U. S. pat. 2,984,396. Filed May 29, 1959. 5 claims. Assigned to Intern. Graphics, Inc. [Cl. 225-47.] A carton is provided for housing and dispensing pressure-sensitive tape from a supply roll.

Gambill, Ulysses T. **Fibrous glass panel.** U. S. pat. 2,984,313. Filed April 24, 1959. 10 claims. Assigned to Owens-Corning Fiberglas Corp. [Cl. 181-33.] A sound and heat insulating panel formed of glass or other fibers is provided.

Gaulke, Arthur W. **Packaging strip having accordion pleated cushions.** U. S. pat. 2,984,399. Filed July 20, 1957. 4 claims. Assigned to Vanant Co., Inc. [Cl. 229-14.] This is a paperboard interior packing member.

Gillam, Edward D. **Dispensing containers for tablets and the like.** U. S. pat. 2,984,397. Filed Dec. 30, 1959. 5 claims. [Cl. 225-49.] The pills are sealed between plastic strips which are coiled in a carton.

Glab, William T. **Methods of making a lignocellulose product and products resulting thereform.** U. S. pat. 2,984,578. Filed Sept. 30, 1958. 3 claims. Assigned to Durel, Inc. [Cl. 106-163.] Lignocellulose and formaldehyde are reacted to form a molding composition.

Glab, William T. **Methods of making a lignocellulose product and products resulting therefrom.** U. S. pat. 2,984,579. Filed Oct. 2, 1958. 6 claims. Assigned to Durel, Inc. [Cl. 106-163.] This is similar to U. S. patent 2,984,580 (May 16, 1961).

Glab, William T. **Methods of making a lignocellulose product and products resulting therefrom.** U. S. pat. 2,984,580. Filed Oct. 8, 1958. 4 claims. Assigned to Durel, Inc. [Cl. 106-163.] A molding composition or board or other shaped article is formed.

Gobalet, Kenneth C. **Method of adhesively bonding foldable board.** U. S. pat. 2,984,598. Filed Jan. 7, 1958. 9 claims. Assigned to Baljak Corp. [Cl. 154-120.] A method is provided for adhering overlapped areas of paperboard together in making a box.

Gordon, James H. **Method of an apparatus for reforming collapsed container bodies.** U. S. pat. 2,984,162. Filed Dec. 23, 1958. 8 claims. Assigned to Am. Can Co. [Cl. 93-53.] The containers are paperboard milk cartons.

Hannon, Donald F. **Identification card.** U. S. pat. 2,984,030. Filed April 18, 1960. 3 claims. Assigned to Laminators, Inc. [Cl. 40-2.2.] The card is a paper-plastic laminate.

Helland, Howard M. **Papermaker's felt.** U. S. pat. 2,983,986. Filed May 6, 1959. 7 claims. Assigned to Lockport Felt Co. [Cl. 28-78.]

Helland, Howard M. **Papermaker's wet felt.** U. S. pat. 2,983,985. Filed June 23, 1958. 7 claims. Assigned to Lockport Felt Co., Inc. [Cl. 28-78.]

Hennes, Richard P. **Method of making electrical conductors on insulating supports.** U. S. pat. 2,984,597. Filed Aug. 15, 1958. 16 claims. Assigned 50% to Leighton R. Johnson, Jr. [Cl. 154-99.] Waxed paper is used as a temporary support for conductive elements in making printed circuits.

Herkender, Frank W. **Snap-top display carton.** U. S. pat. 2,984,401. Filed June 18, 1959. 6 claims. Assigned to General Carton Co. [Cl. 229-41.] This carton is for packaging the bristle portion of a paint brush.

Hotelling, Eric B., and Kelly, Thomas E. **Tobacco composition.** U. S. pat. 2,984,244. Filed April 7, 1960. (Divided; original filed Sept. 30, 1959.) 14 claims. Assigned to Intern. Cigar Machinery Co., Inc. [Cl. 131-15.] Methyl cellulose and other cellulose derivatives are used as adhesive binders.

Huck, William F. **Single rollstand web handling machine.** U. S. pat. 2,984,429. Filed Dec. 6, 1957. 4 claims. [Cl. 242-75.1.] An improved web winder or unwinder is provided.

Jayme, Georg. **Process for the production of cellulose gels with the aid of iron complexes.** U. S. pat. 2,984,581. Filed Dec. 22, 1958. 13 claims. Assigned to Firma Carl Freudenberg. [Cl. 106-163.]

Johnson, Rubel M. **Continuous roll winder.** U. S. pat. 2,984,426. Filed May 23, 1958. 5 claims. [Cl. 242-56.]

Kalinchuk, Donald W. **Packaging and storage devices for cords strung with a succession of spaced objects.** U. S. pat. 2,984,347. Filed Oct. 1, 1958. 17 claims. [Cl. 206-65.] A device formed of plastic and paperboard is provided for packaging a string of Christmas tree lights.

Kist, Karl E. **Sheet registering mechanism and method.** U. S. pat. 2,984,483. Filed May 8, 1958. 10 claims. Assigned to Harris-Intertype Corp. [Cl. 271-58.] Paper sheets are registered while being fed as an underlapped stream.

Kist, Karl E., and Vandeman, Jack E. **Sheet registering mechanism.** U. S. pat. 2,984,482. Filed Dec. 14, 1960. (Divided; original filed May 8, 1958.) 3 claims. Assigned to Harris-Intertype Corp. [Cl. 271-46.] This is related to U. S. patent 2,984,483 (May 16, 1961).

Koch, Werner. **Gripper for use in printing machines.** U. S. pat. 2,984,178. Filed Feb. 10, 1959. (Divided; original filed March 7, 1956.) 4 claims. Assigned to Roland Offsetmaschinenfabrik Faber & Schleicher A. G. [Cl. 101-409.]

Kuchenbecker, Morris W. **Carton lock.** U. S. pat. 2,984,400. Filed June 10, 1959. 5 claims. Assigned to Am. Can Co. [Cl. 229-39.] A tamper-proof carton is provided.

Lytton, Marion R. **Method of forming all skin viscose rayon.** U. S. pat. 2,984,541. Filed April 20, 1959. 16 claims. Assigned to Am. Viscose Corp. [Cl. 18-54.] The coagulation modifier is an alkylene oxide adduct of ethylene-diamine.

Meissner, William E. **Method and apparatus for film sealing.** U. S. pat. 2,984,058. Filed Sept. 29, 1959. 16 claims. Assigned to Am. Viscose Corp. [Cl. 53-42.] A plastic film seal is provided on a cup carrying ice cream or the like.

Oxborrow, Bernard H. **Carton-closing machines.** U. S. pat. 2,984,060. Filed July 1, 1960. 19 claims. Assigned to The Metal Box Co., Ltd. [Cl. 53-388.] A hinged lid carton is closed and heat-sealed.

Pierce, Chester J., Jr. **Method of and device for pivoting articles.** U. S. pat. 2,984,332. Filed Dec. 29, 1959. 10 claims. Assigned to Baljak Corp. [Cl. 198-33.] The device is of use in a system for assembling, filling, and closing folding boxes.

Putnam, Harvey W. P. **Carton construction.** U. S. pat. 2,984,402. Filed June 6, 1958. 3 claims. [Cl. 229-52.] This is a partitioned carton having an extensible handle element.

Richards, Url S. **Automatic bookmark.** U. S. pat. 2,984,205. Filed May 28, 1959. 7 claims. [Cl. 116-119.] The bookmark is formed of paper or paperboard.

Roberts, John W., Daum, Harold, and Donahue, William T. **Apparatus for packing asbestos fibers and the like.** U. S. pat. 2,984,172. Filed Oct. 23, 1956. 3 claims. Assigned to Johns-Manville Corp. [Cl. 100-90.] The fibers are compressed and wrapped.

Rockstrom, Leonard. **Roll winding apparatus.** U. S. pat. 2,984,427. Filed July 25, 1956. 5 claims. Assigned to Camero Machine Co. [Cl. 242-65.] In a web slitter-rewinder, means are provided to compensate for undesirable forces acting on the rewind shaft.

Sampson, George H. **Finder for calendar.** U. S. pat. 2,984,033. Filed Feb. 6, 1959. 1 claim. Assigned to Winthrop Atkins Co., Inc. [Cl. 40-110.] A paperboard easel mount for a calendar is provided with means to indicate any particular day on the calendar sheet.

Schneider, Edmund C., Jr. **Method for decorticating fla**

and enriching the soil. U. S. pat. 2,983,965. Filed Nov. 15, 1954. 6 claims. Assigned to Peter J. Schweitzer, Inc. [Cl. 19-33.]

Scholl, William M. **Method of packaging.** U. S. pat. 2,984,056. Filed May 8, 1958. 1 claim. [Cl. 53-22.] A method of skin packaging is described.

Sherman, Clayton C. **Coated web with water vapor barrier resistance.** U. S. pat. 2,984,585. Filed July 5, 1957. 3 claims. Assigned to H. P. Smith Paper Co. [Cl. 117-76.] Paper is coated with polyethylene, then with wax.

Smith, James E. **Heat sealable label roll and method of making the same.** U. S. pat. 2,984,342. Filed Nov. 24, 1958. 11 claims. Assigned to Crown Zellerbach Corp. [Cl. 206-59.] These are paper-base labels for sealing the ends of bread wrappers.

Smith, James E. **Method of packaging perishable foods.** U. S. pat. 2,984,573. Filed Nov. 24, 1958. 3 claims. Assigned to Crown Zellerbach Corp. [Cl. 99-172.] A coated paper label seal is provided for application to the end of a wrapped loaf of bread.

Stevenson, James J., and Dowden, Philip R. **Paper mill roll.** U. S. pat. 2,983,990. Filed Sept. 29, 1958. 4 claims. Assigned to Continental Rubber Works. [Cl. 29-132.] A paper machine press roll having a finely pitted surface is provided.

Swartz, Richard L., and Highsmith, William D. **Suction-head document feeder.** U. S. pat. 2,984,481. Filed Sept. 27, 1957. 6 claims. Assigned to Universal Business Machines, Inc. [Cl. 271-26.]

Van Antwerpen, Lloyd D., Gaulke, Arthur W., and Hutchinson, Charles R. **Carton for panoramic automobile glass.** U. S. pat. 2,984,343. Filed Feb. 27, 1959. 3 claims. Assigned to Venant Co., Inc. [Cl. 206-62.]

Vischulis, George. **Floating roller mounting for web tension control systems.** U. S. pat. 2,984,430. Filed July 10, 1958. 5 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 242-75.42.]

Whelton, John M., and Knowlton, Norwood H. **Folding apparatus.** U. S. pat. 2,984,160. Filed Aug. 2, 1945. 21 claims. Assigned to United Shoe Machinery Corp. [Cl. 93-1.] A folded paper element is provided as a filter for a gas mask.

May 23, 1961

Acosta, Gabriel I., and Acosta, C. Gonzalo. **Three dimensional greeting card.** U. S. pat. 2,984,920. Filed Jan. 5, 1960. 4 claims. [Cl. 40-124.1.]

Aldington, Elmer T. **Self-conforming cover for containers.** U. S. pat. 2,985,354. Filed Aug. 24, 1959. 8 claims. Assigned to Am. Can Co. [Cl. 229-43.] A paper or plastic cover is provided for a frustoconical paper container of the type used to package cottage cheese.

Amenta, Italo M. **Case packer.** U. S. pat. 2,985,321. Filed Jan. 14, 1958. 9 claims. Assigned to Emhart Mfg. Co. [Cl. 214-6.] The output of a casing machine in which articles are pushed into the case by a pusher element is designed to increase machine output without increasing the speed of the pusher movement.

Anderson, Herbert R. **Triple-wall corrugated board.** U. S. pat. 2,985,553. Filed Sept. 26, 1957. 1 claim. Assigned to Tri-Wall Containers, Inc. [Cl. 154-45.9.]

Arneson, Lawrence E. **Paperboard can package.** U. S. pat. 2,985,294. Filed June 22, 1954. 7 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 206-65.] This is a six-pack can carrier.

Boomer, Daryl R., Clapperton, Edward T., and Phillips, Russell C. **Process for conversion of lignocellulose materials.** U. S. pat. 2,985,643. Filed Jan. 3, 1956. 9 claims. Assigned to Woodduse, Inc. [Cl. 260-124.] Materials such as sawdust or bagasse are converted to agricultural nutrient carriers and soil-conditioning agents.

Debow, Bernard. **Display stands.** U. S. pat. 2,985,313. Filed March 4, 1958. 11 claims. [Cl. 211-135.] The stand is formed of paperboard.

de Monterey, Francis G. A., and Zurlo, Michael J. **Method of rendering cellulosic material non-adherent and article produced thereby.** U. S. pat. 2,985,544. Filed March 26, 1958. 4 claims. Assigned to General Elec. Co. [Cl. 117-143.]

Dickard, Lester R. **Method of rendering a web non-adherent to a pressure-sensitive adhesive and article produced thereby.** U. S. pat. 2,985,554. Filed Aug. 14, 1957. 7 claims. Assigned to Avery Adhesive Prods., Inc. [Cl. 154-53.5.] A release paper for use with pressure-sensitive tape is formed.

Dietrich, Paul. **Apparatus for folding and collecting in rotary printing presses.** U. S. pat. 2,985,449. Filed Aug. 17, 1959. 2 claims. Assigned to Maschinenfabrik Augsburg-Nurnberg A.G. [Cl. 270-50.]

Erdmann, Hans. **Staples of retaining rings.** U. S. pat. 2,985,295. Filed May 24, 1957. 1 claim. Assigned to Waldes Kohinoor, Inc. [Cl. 206-65.] A number of these rings are packaged by unitizing them with paper-backed pressure-sensitive tape.

Force, Gerald E. **Mailing container.** U. S. pat. 2,985,353. Filed Sept. 6, 1957. 4 claims. [Cl. 229-22.] A paperboard tube is provided as a mailing container for blueprints.

Forsythe, Alan K. **Solvent oxidation of linoleum cement.** U. S. pat. 2,985,535. Filed April 6, 1959. 5 claims. Assigned to Armstrong Cork Co. [Cl. 106-123.] A tall oil product is produced for use in linoleum cements.

Gagarine, Dmitry M. **Process of producing flat drying, wet crease resistant cellulosic fabrics by reaction with cross-linking agents and products produced thereby.** U. S. pat. 2,985,501. Filed April 3, 1956. 19 claims. Assigned to Deering Milliken Research Corp. [Cl. 8-120.]

Herzig, Leonard A. **Microfilm record card.** U. S. pat. 2,984,921. Filed April 24, 1959. 5 claims. Assigned to P.C.I., Inc. [Cl. 40-158.] A device for mounting is provided.

Homan, Jan Daniel H., and Ederzeel, Laurens P. **Process for the manufacture of adrenocorticotropic hormone preparations by carboxymethylcellulose chromatography.** U. S. pat. 2,985,560. Filed June 24, 1957. 5 claims. Assigned to Organon, Inc. [Cl. 167-74.]

Honeyman, Robert B. **Automatic safety release for adjusting means for pulp refiners and the like.** U. S. pat. 2,985,388. Filed June 29, 1959. 2 claims. Assigned to Modern Machines Co. [Cl. 241-32.]

Hornbostel, Lloyd. **Calender stack.** U. S. pat. 2,985,100. Filed Jan. 29, 1958. 7 claims. Assigned to Beloit Iron Works. [Cl. 100-163.] Each roll bearing is provided with individual load-relieving means.

Kahn, Martin S. **Display device.** U. S. pat. 2,985,296. Filed Oct. 18, 1957. 3 claims. Assigned to David Kahn, Inc. [Cl. 206-78.] A display pack for ink cartridges includes a paperboard backing card having a plastic blister element mounted on its face.

Knutsson-Hall, Folke K. **Method of manufacturing boxes of cardboard.** U. S. pat. 2,985,075. Filed Jan. 29, 1957. 8 claims. [Cl. 93-36.] A method of folding the blank is provided.

Koehler, James O., and Lamprey, Headlee. **Shaped resins.** U. S. pat. 2,985,604. Filed March 5, 1957. 2 claims. Assigned to Union Carbide Corp. [Cl. 260-23.] Plasticizers are provided for ethyl cellulose and other cellulosic plastics.

Leavitt, Herbert J. **Method of rendering cellulosic material nonadherent and article produced thereby.** U. S. pat. 2,985,545. Filed March 26, 1958. 4 claims. Assigned to General Elec. Co. [Cl. 117-143.] Paper is rendered nonadherent to asphalt, wax, and the like.

Leavitt, Herbert J. **Method of rendering cellulosic material nonadherent and article produced thereby.** U. S. pat. 2,985,546. Filed March 26, 1958. 7 claims. Assigned to General Elec. Co. [Cl. 117-143.] Paper is rendered nonadherent to waxes, asphalt, and the like.

McFarland, Gerald B. **Mailing instrument.** U. S. pat. 2,985,464. Filed March 10, 1958. 5 claims. Assigned to M. B. McFarland & Sons. [Cl. 283-58.] The construction of a bank check includes an envelope-forming portion.

Malek, Mitchell F. **Safety cover for book matches.** U. S. pat. 2,985,286. Filed April 13, 1959. 2 claims. [Cl. 206-29.]

Padgett, John W., and Van Esselstyn, Sherman T. **Wax coating composition and coated article.** U. S. pat. 2,985,538. Filed Sept. 24, 1959. 16 claims. [Cl. 106-270.] A paraffin wax composition for coating milk cartons is provided.

Parker, Clarence E. **Apparatus for handling rigid sheet material.** U. S. pat. 2,985,322. Filed Feb. 7, 1958. 3 claims. Assigned to Coe Mfg. Co. [Cl. 214-6.] The machine provided stacks articles such as sheets of wallboard.

Paxton, Stanley K., Paxton, Kenneth P., and Evans, Elmer E. **Carton stapling machine.** U. S. pat. 2,984,837. Filed July 9, 1959. 15 claims. Assigned to Paxton Sales Corp. [Cl. 1-106.]

Plitt, Karl F. **Aqueous pressure-sensitive adhesive composition comprising polyvinylalcohol and a polyethylene amine, and method of making.** U. S. pat. 2,985,609. Filed Sept. 20, 1957. 3 claims. Assigned to The United States of Am. [Cl. 260-29.6.] This is for use on paper and other backings in the manufacture of tape.

Ranhagen, Ernst G. R. **Impregnation of wood chips.** U. S. pat. 2,985,236. Filed March 20, 1958. 1 claim. Assigned to Aktiebolaget Celleco. [Cl. 162-237.] The impregnation takes place in a continuous digestion system.

Read, Robert E. **Bags and method of making bags.** U. S. pat. 2,985,355. Filed Dec. 3, 1952. 16 claims. [Cl. 229-60.] A handled paper shopping bag with seamless bottom and sift-proof side seams is provided.

Reich, William N. **Diagnostic package.** U. S. pat. 2,985,288. Filed Aug. 10, 1959. 5 claims. Assigned 50% to Stanley C. Schaffer. [Cl. 206-46.] Filter paper is used in the formation of a sterile diagnostic package for human tissue.

Rockstrom, Leonard, and Aaron, Charles. **Roll rewinding device.** U. S. pat. 2,985,398. Filed Oct. 11, 1956. 8 claims. Assigned to Cameron Machine Co. [Cl. 242-65.]

Schulz, Ralph H. **Rupturable packages and components**

thereof. U. S. pat. 2,985,287. Filed Feb. 14, 1958. 8 claims. Assigned to Freeman Chem. Corp. [Cl. 206-46.] A fragile carton is protected within an outer carton by a polyurethane foam formed *in situ*.

Shell, Francis J. **Cement compositions and process of cementing wells.** U. S. pat. 2,985,239. Filed June 25, 1956. 35 claims. Assigned to Phillips Petroleum Co. [Cl. 166-31.] Cellulose derivatives are used.

Stein, Werner, and Offermann, Willy. **Composition of matter comprising a high molecular weight polymer and an acetal or ketal of a hydroxycarboxylic acid.** U. S. pat. 2,985,536. Filed March 27, 1957. 6 claims. Assigned to Dehydag, Deutsche Hydrierwerke G.m.b.H. [Cl. 106-176.] These are plasticizers for cellulose nitrate and the like.

Strahammer, Josef V. **Machine for convoluting soda straws or the like.** U. S. pat. 2,985,077. Filed Dec. 4, 1957. 10 claims. Assigned to Sidney G. Graham. [Cl. 93-77.]

Summerfield, John M. **Process and apparatus for producing plasterboard.** U. S. pat. 2,985,219. Filed Dec. 29, 1958. 11 claims. Assigned to U. S. Gypsum Co. [Cl. 154-1.]

Tashiro, Frank K. **Means for dispensing coiled wire from a container.** U. S. pat. 2,985,404. Filed June 16, 1958. 6 claims. [Cl. 242-128.]

Thorn, Harry F. **Paperboard forming and cutting apparatus.** U. S. pat. 2,985,223. Filed April 11, 1958. 3 claims. Assigned to Koppers Co., Inc. [Cl. 154-31.] Automatic changeover means are provided in a blank-forming system consisting of double facer, slitter-scorer, and cutoff.

Toennies, Owe M. **Packaging machine.** U. S. pat. 2,985,076. Filed Feb. 29, 1960. 4 claims. Assigned to Grove Research & Devt. Co. [Cl. 93-49.] Frankfurters are packaged in paperboard members.

Van Strien, Richard E., and Bolton, Benjamin A. **Alkyd resin utilizing trimellitic anhydride and tall oil.** U. S. pat. 2,985,603. Filed Sept. 12, 1958. 8 claims. Assigned to Standard Oil Co. [Cl. 260-22.]

Vogt, Clarence W. **Blowing head for packaging apparatus.** U. S. pat. 2,985,340. Filed Nov. 5, 1956. 10 claims. [Cl. 222-189.] This is a machine for filling containers with flour or the like.

Von Kohorn, Oscar. **Manufacture of viscose spinning solution.** U. S. pat. 2,985,647. Filed Jan. 12, 1959. 8 claims. [Cl. 260-217.]

Wainwright, George R. **Machine for forming packages with tear string.** U. S. pat. 2,984,958. Filed June 15, 1959. 3 claims. Assigned to Bartelt Eng. Co. [Cl. 53-133.] Bags with tear string are formed, filled, and sealed.

Walther, Erhardt, and Dammig, Werner. **Package filling.** U. S. pat. 2,984,959. Filed Sept. 8, 1958. (Divided; original filed Jan. 19, 1954.) 9 claims. Assigned to Regnitz Konstruktionsgellschaft m.b.H. [Cl. 53-374.] Folding boxes are filled and closed.

Watkins, Spencer H. **Rosin size having improved crystallization characteristics.** U. S. pat. 2,985,537. Filed July 8, 1955. 5 claims. Assigned to Hercules Powder Co. [Cl. 106-238.]

White, William D. **Openable binder rings and book binders.** U. S. pat. 2,985,173. Filed July 2, 1959. 11 claims. [Cl. 129-24.]

Wilson, Harry W., and Dornbush, Clinton L. **Machine for packaging cartons.** U. S. pat. 2,985,323. Filed Oct. 17, 1958. (Divided; original filed April 29, 1957.) 3 claims. Assigned to Royal Container Co. [Cl. 214-6.] The machine provided automatically palletizes stacks of flattened paperboard boxes.

May 30, 1961

Anderson, Wilbur G., Jr. **Receptacle having a handle.** U. S. pat. 2,986,324. Filed Jan. 23, 1958. 4 claims. Assigned to Am. Box Board Co. [Cl. 229-52.] A large carton for household soaps is provided with an integral extensible handle element.

Atkinson, William G. **End closures for containers.** U. S. pat. 2,986,322. Filed March 10, 1960. 1 claim. Assigned to Somerville, Ltd. [Cl. 229-34.] A cylindrical paperboard container for ice cream is provided with an easily removed end closure disk.

Baxter, Joseph, Jr. **Paper machinery.** U. S. pat. 2,986,434. Filed Oct. 12, 1959. (Divided; original filed Feb. 13, 1957.) A claims. Assigned to The Black-Clawson Co. [Cl. 308-187.] A paper stock refiner is provided with an improved drive.

Bennett, Clifford B. **Wrapping machines.** U. S. Re. pat. 24,993. Filed July 14, 1958. (Divided; original filed May 6, 1958.) 22 claims. Assigned to Southern Saw Service, Inc. [Cl. 53-13.] A paper wrapper is applied to an endless band saw blade.

Bierman, Clarence R., and Hoag, Lehman E. **Venting container and method of making same.** U. S. pat. 2,986,319. Filed Oct. 2, 1957. 3 claims. Assigned to Am. Can Co. [Cl. 229-5.6.] An internal pressure-resistant paperboard can for uncooked dough is designed to vent gases formed within the can.

Eichel, Herman J. **Adhesive tape.** U. S. pat. 2,986,477. Filed June 19, 1958. 1 claim. Assigned to The Natl. Cash Register Co. [Cl. 117-122.] This is a paper-base tape.

Forrer, Homer W. **Wrapper carton for group packaging of different sized articles.** U. S. pat. 2,986,271. Filed April 23, 1958. 2 claims. Assigned to The Mead Corp. [Cl. 206-65.] A paperboard wrapper is used to unitize two cans of different size and shape.

Frasch, Mary E. **Paper head-dress.** U. S. pat. 2,985,886. Filed Jan. 6, 1958. 7 claims. [Cl. 2-209.3.]

Gelpke, Karl. **Method and device for joining envelopes and similar articles to form a continuous band thereof.** U. S. pat. 2,986,077. Filed Jan. 24, 1958. 7 claims. Assigned to Berkley Machine Co. [Cl. 93-1.]

Goldberg, Ernest. **Package for tea or other infusion commodities.** U. S. pat. 2,986,269. Filed Nov. 9, 1959. 11 claims. [Cl. 206-.5.] A paper cone attachment for an infusion bag is provided to assist in squeezing liquid from the bag.

Habgood, Warren J. **Apparatus for taping objects on object holders.** U. S. pat. 2,985,991. Filed May 22, 1959. 11 claims. [Cl. 53-198.] An object is taped onto a packaging card.

Hartmann, Louis M., and Hansen, Albert B. A. **Machine for the manufacture of articles from fiber pulp.** U. S. pat. 2,986,211. Filed Feb. 24, 1958. 4 claims. Assigned to Aktieselskabet Brodrene Hartmann. [Cl. 162-391.] Molded pulp articles are formed.

Harwood, Kenneth J. **Cellulosic product.** U. S. pat. 2,986,270. Filed Feb. 10, 1958. 6 claims. Assigned to Kimberly-Clark Corp. [Cl. 206-45.33.] A wrapping material comprises polyethylene film having paper strips sealed to each longitudinal edge of the film.

Hotterdorf, William J. **Folding machine for glued flap boxes.** U. S. pat. 2,986,078. Filed March 25, 1957. 2 claims. Assigned to H & C Eng. Corp. [Cl. 93-52.]

Kruse, Elmer A. **Package for box-like containers.** U. S. pat. 2,986,272. Filed July 2, 1958. 4 claims. Assigned to Wagner Elec. Corp. [Cl. 206-65.] Several rectangular containers are unitized with a paperboard wrapper.

Larson, Donald W. **Dual dispenser and shaker insert.** U. S. pat. 2,986,309. Filed Jan. 19, 1959. 13 claims. [Cl. 222-480.] This is a plastic device for insertion in a cylindrical carton for sugar or the like.

Loderhose, Richard E. **Phonograph jacket and method of making same.** U. S. pat. 2,986,325. Filed Feb. 29, 1960. claims. [Cl. 229-68.]

Maxwell, Charles S. **Melamine resin colloid and manufacture of wet-strength paper therewith.** U. S. pat. 2,986,489. Filed Jan. 28, 1958. 12 claims. Assigned to Am. Cyanamid Co. [Cl. 162-166.]

Meyer, Hans, and Dolman, Henry J. **Marking articles.** U. S. pat. 2,986,298. Filed June 24, 1957. 14 claims. [Cl. 216-29.] Thermoplastic-coated paper labels are affixed to garments.

Nicholls, Herbert C., and Huisheere, Oliver. **Container.** U. S. pat. 2,986,320. Filed March 28, 1960. 5 claims. Assigned to Consolidated Water Power & Paper Co. [Cl 229-6.] This is a stackable tray-and-cover container for freezing and shipping poultry.

Outterson, Charles R. **Process for making flameproofed water-resistant paper.** U. S. pat. 2,986,478. Filed Oct. 29, 1958. 12 claims. Assigned to The Albemarle Paper Mfg. Co. [Cl. 117-137.]

Raifsnider, Philip J. **Vapor phase corrosion inhibition.** U. S. pat. 2,986,447. Filed June 9, 1959. 4 claims. Assigned to Shell Oil Co. [Cl. 21-2.5.] In VPI paper, the active agent is caprylic acid.

Randall, Walter H., and Emery, Richard L. **Method of making molded pulp articles.** U. S. pat. 2,986,490. Filed Oct. 7, 1955. (Divided; original filed Oct. 15, 1951.) 6 claims. Assigned to Keyes Fibre Co. [Cl. 162-222.]

Ritzerfeld, Wilhelm, and Ritzerfeld, Gerhard. **Transfer sheets and method of making the same.** U. S. pat. 2,986,471. Filed March 11, 1958. 8 claims. [Cl. 117-16.] A paper-base transfer sheet of use in imaging a lithographic foil is provided.

Rudd, Eugene D. **Surface-protective film-forming material.** U. S. pat. 2,986,471. Filed Oct. 9, 1957. 5 claims. [Cl. 106-2.] Sodium carboxymethyl cellulose is used in a coating composition for autos.

Schaich, Wilbur A. **Dual purpose shipping carton.** U. S. pat. 2,986,321. Filed Oct. 14, 1960. 4 claims. Assigned to Owens-Illinois Glass Co. [Cl. 229-23.] A bulk produce shipper converts into three smaller cartons.

Shepard, Viola L. **Plastic recipe file.** U. S. pat. 2,986,143. Filed June 4, 1959. 1 claim. [Cl. 129-20.] This is a booklike device for mounting cards or other sheet materials.

Siegrist, Adolf Emil, Duennenberger, Max, and Grubenmann, Werner. **Method of optically brightening organic materials and preparations therefor.** U. S. pat. 2,986,528. Filed March 1957. 20 claims. Assigned to Ciba, Ltd. [Cl. 252-301.2] Paper, pulp, and the like are optically brightened.

Smith, John Oliver, and Gardner, Brian Conrad. **Crimped**

regenerated cellulose fibres. U. S. pat. 2,986,446. Filed July 25, 1957. 9 claims. Assigned to Courtaulds Ltd. [Cl. 18-54.]

Triolo, Louis. **Envelope lining machine.** U. S. pat. 2,986,079. Filed March 25, 1960. 15 claims. [Cl. 93-61.]

Ultee, Arnoldus J. **Process for stabilizing solutions of cellulose derivatives.** U. S. pat. 2,986,558. Filed July 31, 1958. Assigned to E. I. du Pont de Nemours and Co. [Cl. 260-212.]

Waite, Fred L., and Graubert, Seth H. **Registration device for wrapping machines.** U. S. pat. 2,985,990. Filed April 22, 1958. 11 claims. Assigned to Am. Machine & Foundry Co. [Cl. 53-51.]

Walker, Robert G. **Collating machine.** U. S. pat. 2,986,391. Filed March 19, 1958. (Divided; original filed Sept. 27, 1956.) 5 claims. Assigned to Halverson Prod. Mfg. Co. [Cl. 270-58.]

Weisgerber, Cyrus A., and Davis, James W. **Method of sizing paper.** U. S. pat. 2,986,488. Filed Feb. 27, 1957. 3 claims. Assigned to Hercules Powder Co. [Cl. 162-158.] Ketene dimers are used.

Wichman, Merle A. **Carton.** U. S. pat. 2,986,323. Filed Dec. 30, 1959. 3 claims. Assigned to American Can Co. [Cl. 229-36.] The hinged lid is provided with means to lock the tuck flap of the lid into closed position.

Wiley, Albert L. **Digester screen.** U. S. pat. 2,986,232. Filed Jan. 24, 1958. 7 claims. Assigned to Riegel Paper Corp. [Cl. 183-14.] The screen permits the escape of gases without the entrainment of fibers.

June 6, 1961

Murray, Maija L., and Ward, Kyle, Jr. **Method of making pulp.** U. S. pat. 2,987,434. Filed Sept. 9, 1958. 9 claims. Assigned to The Inst. of Paper Chemistry. [Cl. 162-157.] This is similar to U. S. patent 2,987,433 (June 6, 1961).

Sweitzer, Charles S., and Brock, Jon. **Apparatus for producing multi-ply paperboard products.** U. S. pat. 2,987,122. Filed Oct. 12, 1955. 3 claims. Assigned to Diamond Natl. Corp. [Cl. 162-304.]

Ward, Kyle, Jr., and Walecka, Jerrold A. **Process for making paper and the product thereof.** U. S. pat. 2,987,433. Filed Nov. 10, 1955. 4 claims. Assigned to The Inst. of Paper Chemistry. [Cl. 162-157.] The pulp is chemically modified, as by carboxymethylation, so as to require less beating and provide a paper of enhanced strength.

Whitney, Roy P., Han, Shu-Tang, Bakken, James F., and Kesler, Richard B. **Treatment of spent sulfite liquor.** U. S. pat. 2,987,432. Filed Aug. 6, 1957. 7 claims. Assigned to The Inst. of Paper Chemistry. [Cl. 162-36.]

June 13, 1961

Bradway, Keith E., and Yundt, Albert P. **Method and apparatus for continuous countercurrent pulping of lignocellulose materials.** U. S. pat. 2,988,470. Filed May 12, 1959. 5 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 162-17.]

Brook, Leonard. **Wrapping machines.** U. S. pat. 2,987,861. Filed Nov. 27, 1959. 7 claims. Assigned to The Forgrove Machinery Co., Ltd. [Cl. 53-225.] Articles such as small round tablets are wrapped.

Callinicos, James N. **Adjustable floral package.** U. S. 2,988,259. Filed July 28, 1959. 6 claims. [Cl. 229-34.] The carton provided may be erected in different ways to handle the different articles sold by a florist.

Chandler, Grover C. **Apparatus for closing a carton.** U. S. pat. 2,987,973. Filed March 24, 1959. 4 claims. Assigned to Am. Can Co. [Cl. 93-52.]

Eichel, Herman J. **Adhesive tape.** U. S. pat. 2,988,461. Filed June 16, 1958, 1 claim. Assigned to The Natl. Cash Register Co. [Cl. 117-122.] This is a paper-backed tape.

Emmons, William D., and Wadsworth, William S., Jr. **Process for creaseproofing cellulosic fabrics.** U. S. pat. 2,988,417. Filed Dec. 29, 1958. 14 claims. Assigned to Rohm & Haas Co. [Cl. 8-116.]

Evans, Douglas C. **Display card device for bobby pins or the like.** U. S. pat. 2,988,210. Filed Aug. 14, 1958. 1 claim. Assigned to Scolding Locks Corp. [Cl. 206-66.]

Fitch, Robert B. **Mechanism for selecting containers according to length.** U. S. pat. 2,988,214. Filed Nov. 26, 1957. 8 claims. Assigned to Stapling Machines Co. [Cl. 209-71.] The device provided halts all containers of a certain length as containers of mixed lengths are passed along a conveyor.

Forth, Edward W., and Crescenzo, Francis. **Feeding of frozen foods in a vertical flow packaging machine.** U. S. pat. 2,987,859. Filed Aug. 8, 1960. 10 claims. Assigned to Package Machinery Co. [Cl. 53-177.]

Garfield, Isadore W. **Deodorant unit.** U. S. pat. 2,988,283. Filed Feb. 19, 1958. 4 claims. [Cl. 239-52.] A ceramic deodorant unit fits inside the core of a roll of toilet paper or paper toweling.

Guyer, Reynolds, and Anderson, Carl E. **Hinged top carton.** U. S. pat. 2,988,262. Filed July 12, 1957. 3 claims. [Cl. 229-44.] This is a flip-top cigarette box.

Hänsel, Otto. **Apparatus for packing small objects especially chocolate bodies, candies, or the like.** U. S. pat. 2,987,862. Filed May 28, 1957. 7 claims. [Cl. 53-234.]

Harms, Harold H. **Pleated filter.** U. S. pat. 2,988,227. Filed March 3, 1958. 8 claims. [Cl. 210-493.] This is a paper element.

Howe, Milton A., Jr. **Packaging apparatus.** U. S. pat. 2,987,860. Filed March 24, 1959. 3 claims. Assigned to W. R. Grace & Co. [Cl. 53-206.] A diamond wrap is applied about a food article in a tray.

Hunt, Harold Roy. **Impregnating lignocellulose hardboard with hydrocarbon drying oils.** U. S. pat. 2,988,462. Filed Aug. 20, 1956. 2 claims. Assigned to Masonite Corp. [Cl. 117-143.]

Janson, Bengt G. **Arrangement for removal of resin and/or dewatering of pulp.** U. S. pat. 2,988,223. Filed Feb. 5, 1959. 2 claims. Assigned to Aktiebolaget Celleco. [Cl. 210-346.]

Keating, Jerome V. **Collapsible cigarette package with cover.** U. S. pat. 2,988,261. Filed Oct. 24, 1956. 2 claims. [Cl. 229-38.]

Kerker, William C. **Method of closing bag tube ends.** U. S. pat. 2,987,858. Filed April 30, 1959. 6 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 53-27.]

Klein, Joseph J. **Air filter.** U. S. pat. 2,988,169. Filed Aug. 6, 1957. 8 claims. Assigned to Fiber Bond Corp. [Cl. 183-49.] The filter is formed of a web of nonwoven fibers.

Locke, Frank W., and Dahle, Vincent S. **Paint trays.** U. S. pat. 2,988,260. Filed Nov. 2, 1959. 6 claims. Assigned to Waldorf Paper Prods. Co. [Cl. 229-34.] The tray is made of paperboard.

Loew, Theodore. **Food package.** U. S. pat. 2,988,208. Filed Dec. 20, 1956. 5 claims. Assigned to National Dairy Prods. Corp. [Cl. 206-56.] Individual food servings are packed in a cup of stretchable paper covered with a flat top of pliofilm.

Lovelace, John L. **Container for ready-mix concrete.** U. S. pat. 2,988,207. Filed Aug. 18, 1958. 1 claim. [Cl. 206-47.] An outer paper bag holds the concrete aggregate, an inner plastic bag holds the cement.

Madden, Ralph J., Pennau, Karl L., and Robinson, James E. **Papermaking machine.** U. S. pat. 2,988,141. Filed May 11, 1959. 4 claims. Assigned to Kimberly-Clark Corp. [Cl. 162-257.] Means are provided to cause a lateral oscillation of the fourdrinier wire.

Maier, Lorenz. **Transporting apparatus for cards.** U. S. pat. 2,988,356. Filed Sept. 8, 1958. 16 claims. Assigned to Firma Kienzie Apparate G.m.b.H. [Cl. 271-4.] Means are provided for holding and conveying cards in an apparatus for punching the cards.

Mannhardt, Wilbert P. **Automatic bag dispenser.** U. S. pat. 2,988,245. Filed Sept. 2, 1958. 2 claims. [Cl. 221-42.] An ice cube-vending machine is provided with means to hold and dispense folded paper bags.

Marshall, Edward C., and Swett, Robert W. **Combination booklet tag.** U. S. pat. 2,987,840. Filed Feb. 5, 1958. 10 claims. Assigned to Am. Tag Co. [Cl. 40-2.]

Mazurek, Robert C. **Clarification of acidic phosphatic solutions.** U. S. pat. 2,988,504. Filed Dec. 30, 1957. 14 claims. Assigned to Intern. Minerals & Chem. Corp. [Cl. 210-53.] Tall oil is used.

Miller, Harmon B. **Wrapping device.** U. S. pat. 2,987,864. Filed March 4, 1959. 1 claim. Assigned to Miller & Miller, Inc. [Cl. 53-390.] The machine applies three types of wrappings to articles of produce which may or may not be held in trays or cartons.

Nowak, Leon J., Jr. **Bag opener.** U. S. pat. 2,987,863. Filed June 6, 1958. 16 claims. [Cl. 53-384.] Bags having a flat automatic bottom are opened and held to receive a charge of material such as coffee.

Olson, Reuben A. **Refuse receptacle for use in automobiles and the like.** U. S. pat. 2,988,206. Filed Oct. 7, 1957. 2 claims. [Cl. 206-19.5.] The receptacle is formed of paperboard.

Parrilla, John A. **Combined package of articles and package opening and article ejecting means.** U. S. pat. 2,988,209. Filed Sept. 10, 1957. 1 claim. [Cl. 206-56.] A tear tape opener-ejector is provided in a chewing gum pack.

Quinn, Robert G. **Composition calender roll.** U. S. pat. 2,987,802. Filed Dec. 31, 1957. 5 claims. Assigned to Johns-Manville Corp. [Cl. 29-125.] A paper machine calender roll is formed of asbestos paper.

Rabinow, Jacob, Rosenberg, Harold J., and MacDonald, John G. M. **Single letter feeding device.** U. S. pat. 2,988,355. Filed May 4, 1959. 8 claims. Assigned 85% to Rabinow, and 15% to Max L. Libman. [Cl. 271-2.]

Ranger, Arthur W. **Sheet handling device for printing machines.** U. S. pat. 2,988,357. Filed Dec. 31, 1958. 7 claims. Assigned to Schnellpressenfabrik AG., Heidelberg. [Cl. 271-82.] Paper sheets are registered.

Russell, Lee E. **Machine for opening and handling cartons of packaging machinery.** U. S. pat. 2,987,974. Filed Nov. 19,

1957. 30 claims. Assigned to Crompton-Knowles Pkg. Corp. [Cl. 93-53.]

Scott, Harold E. B. **Doctors for paper and like machines.** U. S. pat. 2,987,748. Filed April 2, 1959. 12 claims. Assigned to Vickerys Ltd. [Cl. 15-256.5.]

Shields, Albert F. **Blank stacking, straightening, and delivery device.** U. S. pat. 2,988,236. Filed Dec. 4, 1956. 5 claims. Assigned to S & S Corrugated Paper Machinery Co., Inc. [Cl. 214-6.]

Strickel, William R., and Kihlstrum, Elmer E. **Blanks of nonwoven fabrics.** U. S. pat. 2,988,468. Filed Aug. 22, 1957. 4 claims. Assigned to Johnson and Johnson. [Cl. 154-46.] The fabric is used in making doll dresses and the like.

Supinger, William M. **Filter system and cartridge.** U. S. pat. 2,988,225. Filed Aug. 18, 1958. 4 claims. [Cl. 210-439.] A filter cartridge for motor lube oil is formed of a body of wood fibers.

Thevenon, Henri. **Process for the manufacture of high voltage electric cable with multipart insulation.** U. S. pat. 2,988,467. Filed March 14, 1955. 3 claims. Assigned to Compagnie Generale d'Electricite. [Cl. 154-2.27.] Paper tape is used.

Watson, Paul C. **Method for the production of reticulated webs.** U. S. pat. 2,988,469. Filed Dec. 22, 1959. 11 claims. Assigned to Am. Viscose Corp. [Cl. 154-101.] A nonwoven fibrous mat is formed.

Whelan, James P. **Method producing infusion bags.** U. S. pat. 2,987,857. Filed Oct. 22, 1958. 16 claims. Assigned to Pneumatic Scale Corp. [Cl. 53-14.]

Wittemeier, Hans-Joachim, and Becker, Fritz. **Air filter.** U. S. pat. 2,988,168. Filed May 14, 1957. 5 claims. Assigned to Delbag-Luftfilter G.m.b.H. [Cl. 183-45.] The filter is formed of a bonded nonwoven fiber mat.

Zahn, Helmut. **Readily removable artificial sausage casings and method of preparation.** U. S. pat. 2,988,451. Filed July 1, 1958. 4 claims. Assigned to Naturin-Werk Becker & Co. [Cl. 99-176.] The inside of the casing is coated with carboxymethyl cellulose.

June 20, 1961

Apel, Alfons. **Conversion of wood sugars to polyols.** U. S. pat. 2,989,569. Filed June 17, 1958. 1 claim. Assigned to UDIC Société Anonyme. [Cl. 260-635.]

Bergstrom, Harold A. **Reinforced drum body.** U. S. pat. 2,989,218. Filed Feb. 5, 1958. 4 claims. Assigned to Continental Can Co., Inc. [Cl. 229-5.5.] This is a metal band-reinforced fiber drum.

Bevier, Theodore S. **Automatic tape dispenser.** U. S. pat. 2,988,944. Filed Sept. 26, 1956. 10 claims. [Cl. 83-233.]

Bodendoerfer, Raymond E. **Blank feeding mechanism for cone cup machines.** U. S. pat. 2,988,968. Filed Dec. 24, 1958. 6 claims. Assigned to Paper Machinery Corp. [Cl. 93-36.2.]

Bombardier, Joseph Armand. **Tree delimbing jaws.** U. S. pat. 2,989,097. Filed July 26, 1960. 7 claims. [Cl. 144-208.]

Butler, Ralph R. **Combination carton and tray for paper.** U. S. pat. 2,989,221. Filed Sept. 22, 1958. 1 claim. Assigned to Hammermill Paper Co. [Cl. 229-15.]

Chaffee, Arthur W. **Combination tape dispenser and removable label moistener.** U. S. pat. 2,989,025. Filed June 23, 1959. 9 claims. [Cl. 118-43.]

Dickinson, Arthur H. **Automatic sorting machine.** U. S. pat. 2,989,181. Filed Dec. 30, 1955. 13 claims. Assigned to Intern. Business Machines Corp. [Cl. 209-111.] Record cards are sorted.

Dreyer, John A. **Handling apparatus.** U. S. pat. 2,989,195. Filed Nov. 15, 1957. 7 claims. Assigned to Benner Newman, Inc. [Cl. 214-6.] Cartons are removed from a conveyor and stacked on a pallet.

Dudnick, Solis, and Leonard, Gordon M. **Method and apparatus for applying handles to paper cups.** U. S. pat. 2,988,967. Filed Feb. 13, 1959. 8 claims. Assigned to National Mfg. Co. [Cl. 93-36.]

Ekenstam, Bo. T. af, and Svensson, Fritz R. **Packing arrangement for objects enclosed in a band provided with compartments.** U. S. pat. 2,989,212. Filed Dec. 2, 1958. 5 claims. Assigned to Kooperativa Forbundet. [Cl. 221-25.] Tablets are sealed between folds in an accordion folded strip and the assembly enclosed in a dispensing container.

Ellingsen, Florence G. **Bookmark and page holding device.** U. S. pat. 2,989,023. Filed Oct. 1, 1958. 3 claims. [Cl. 116-119.]

Geist, William L. **Method of making paper can body with telescopic sections.** U. S. pat. 2,988,970. Filed May 27, 1959. 7 claims. Assigned to R. C. Can Co. [Cl. 93-94.]

Gibbs, Thomas H., Jr. **Container and cover assembly for corrosive materials.** U. S. pat. 2,989,208. Filed April 24, 1958. 9 claims. Assigned to Continental Can Co., Inc. [Cl. 220-27.] Corrosion of the metal ends of a fiber drum is prevented.

Glattli, Hans H. **Punching device.** U. S. pat. 2,989,228. Filed Dec. 12, 1958. 9 claims. Assigned to Intern. Business Machines Corp. [Cl. 234-50.] An apparatus is provided for selectively forming holes in a record card.

Greeman, Norman L., Zagusta, John A., and Anderson, Paul L. **Process for making a printed circuit.** U. S. pat. 2,988,839. Filed June 13, 1956. 1 claim. Assigned to Rogers Corp. [Cl. 41-37.] The base is a laminate of resin-impregnated cellulose fiber sheets.

Haffenreffer, Robert H. **Box construction.** U. S. pat. 2,989,222. Filed Sept. 11, 1959. 12 claims. Assigned to Ellis Paperboard Prods., Inc. [Cl. 229-15.] A partitioned carton is provided.

Harrington, Robert C., Jr., and Smith, James L. **Flameproof cellulose organic acid ester fibers and process for their preparation.** U. S. pat. 2,989,406. Filed Dec. 12, 1957. 7 claims. Assigned to Eastman Kodak Co. [Cl. 106-15.]

Hasselhoff, Carl S. **Special receptacles.** U. S. pat. 2,989,176. Filed June 11, 1958. 1 claim. Assigned to The Eastern Box Co. [Cl. 206-65.] A group of cans or the like is unitized with a band, the group is cartoned, and dry ice is packed in the carton on top of the group.

Helbing, Clarence H. **Method and apparatus for coating a fibrous base.** U. S. pat. 2,989,422. Filed Aug. 30, 1957. 9 claims. Assigned to Pittsburgh Plate Glass Co. [Cl. 117-111.] A method of coating a nonwoven fibrous web is designed to compensate for variations in web thickness.

Herbst, John H. E., and Krässig, Hans A. **Bromide as bleaching catalyst.** U. S. pat. 2,989,519. Filed April 23, 1959. 5 claims. Assigned to Canadian Intern. Paper Co. [Cl. 260-212.] The catalyst is used in the hypochlorite bleaching of pulp.

Hornbostel, Lloyd. **Counter roll winder.** U. S. pat. 2,989,262. Filed May 19, 1958. 12 claims. Assigned to Beloit Iron Works. [Cl. 242-56.]

Jekel, Wilhelmus J. A. **Packing for bottles and similar, substantially cylindrical, containers.** U. S. pat. 2,989,175. 3 claims. [Cl. 206-65.] An interior packing member is provided for use in packing bottles into an outer carton.

Keller, Robert C. **Flotation agent for the purification of waste waters from the paper and cellulose industries.** U. S. pat. 2,989,471. Filed May 4, 1959. 6 claims. Assigned to Fidelity Union Trust Co. [Cl. 252-61.]

Leone, Salvatore J. **Holder for cards or plates and method of making it.** U. S. pat. 2,989,189. Filed Dec. 14, 1959. 3 claims. Assigned to The New Haven Board and Carton Co. [Cl. 211-41.] This is a tray formed of single-face corrugated.

Lorenian, Zareh. **Manufacture of pencils and other shaped articles.** U. S. pat. 2,988,784. Filed July 26, 1956. 8 claims. [Cl. 18-59.] Cellulose derivatives, paper flour, and the like are used in a molding composition for making pencil sheaths.

MacDougall, Anne J., Lohnes, Howard E., and Krekovich, James J. **Animated greeting card.** U. S. pat. 2,988,845. Filed June 17, 1957. 4 claims. Assigned to Hallmark Cards, Inc. [Cl. 46-37.]

Magazzu, John T. **Container with cover lock.** U. S. pat. 2,989,223. Filed Sept. 11, 1959. 7 claims. Assigned to Container Corp. of Am. [Cl. 229-16.] This is a shipper for bulk produce.

Mattingly, John J., and Mattingly, Ralph J. **Can spacing device for a can labeling machine.** U. S. pat. 2,989,167. Filed Dec. 24, 1958. (Divided; original filed Jan. 20, 1955.) 6 claims. [Cl. 198-34.]

Overton, Dolph D. **Closure construction.** U. S. pat. 2,989,220. Filed March 17, 1959. 9 claims. Assigned to Overton Container Corp. [Cl. 229-5.7.] Means are provided for attaching wooden closure disks to the ends of a roughly cylindrical body portion made of paperboard, as in a tobacco cask.

Overton, Dolph D. **Closure construction for containers.** U. S. pat. 2,989,219. Filed March 17, 1959. 16 claims. Assigned to Overton Container Corp. [Cl. 229-5.7.] This is similar to U. S. patent 2,989,220 (June 20, 1961).

Pecker, Calman. **Method of imparting dimensional stability to felt backed surface coverings.** U. S. pat. 2,989,414. Filed Dec. 31, 1958. 6 claims. Assigned to Congoleum-Nairn Inc. [Cl. 117-14.]

Pulaski, Frank P. **Core wrapping apparatus.** U. S. pat. 2,989,430. Filed Feb. 11, 1959. 11 claims. Assigned to Plastic Wire & Cable Corp. [Cl. 154-2.26.] Electrical conductors are wrapped in tape.

Ramm, Joseph L. **Shingle feeding apparatus.** U. S. pat. 2,989,306. Filed Jan. 2, 1958. 11 claims. Assigned to Johns-Manville Corp. [Cl. 271-5.]

Rutenberg, Morton W., and Volpe, Joseph L. **Sulfonium ether derivatives of starch.** U. S. pat. 2,989,520. Filed April 22, 1959. 1 claim. Assigned to Natl. Starch and Chem. Corp. [Cl. 260-233.3.] These ethers are of use in paper sizing.

Sanderson, James J. **Coating composition comprising nitrocellulose, polymer of methyl methacrylate and carbon black.** U. S. pat. 2,989,492. Filed March 17, 1959. 2 claims. Assigned to E. I. du Pont de Nemours & Co. [Cl. 260-17.]

Sattler, Frank A., and Trunzo, Floyd F. **Composition comprising polyesteramide, epoxy resin, and isocyanate modified cellulose**

acetate and wire coated therewith. U. S. pat. 2,989,491. Filed June 5, 1958. 3 claims. Assigned to Westinghouse Elec. Corp. [Cl. 260-16.]

Senti, Frederic R., Mellies, Russell L., and Mehltretter, Charles L. **Method of cross-linking and oxidizing starch.** U. S. pat. 2,989,521. Filed June 30, 1959. 3 claims. Assigned to the United States of America. [Cl. 260-233.3.]

Shepherd, Ridgley G., Jr. **Heat transfer.** U. S. pat. 2,989,413. Filed Oct. 6, 1958. 2 claims. Assigned to Dennison Mfg. Co. [Cl. 117-3.2.] The transfer is backed with paper.

Stratton, Edwin J. D., and Steidinger, Donald J. **Continuous form envelopes with gummed flaps and method of making same.** U. S. pat. 2,988,969. Filed April 5, 1956. 8 claims. Assigned to Uarco, Inc. [Cl. 93-61.]

Swartz, Henry D. **Collapsible containers.** U. S. pat. 2,989,226. Filed June 4, 1957. 2 claims. [Cl. 229-41.] The side walls are plastic, top and bottom portions are paperboard.

Thumm, Byron A. **All skin viscose rayon and method of preparing same.** U. S. pat. 2,989,410. Filed July 26, 1957. (Divided; original filed June 29, 1955.) 2 claims. Assigned to Am. Viscose Corp. [Cl. 106-165.] The coagulation modifier is ethylenediamine.

Thumm, Byron A. **Method of preparing all skin viscose.** U. S. pat. 2,989,366. Filed June 29, 1955. 3 claims. Assigned to Am. Viscose Corp. [Cl. 18-54.] The coagulation modifier is ethylenediamine.

Umanoff, Martin. **Box with pouring spout.** U. S. pat. 2,989,224. Filed Aug. 28, 1957. 2 claims. Assigned to R. A. MacPlum Inds., Inc. [Cl. 229-17.]

Wagenfeld, Gilbert B. **Visor construction.** U. S. pat. 2,988,743. Filed Oct. 28, 1957. 2 claims. [Cl. 2-12.] A visored headpiece is formed from paperboard.

Waldrop, Charles R. **Shipping carton.** U. S. pat. 2,989,225. Filed June 8, 1959. 5 claims. Assigned to Borg-Warner Corp. [Cl. 229-23.] This is a carton for heavy goods such as washing machines or the like.

Weidenhammer, James A. **Sheet feeding apparatus.** U. S. pat. 2,989,307. Filed Nov. 12, 1958. 7 claims. Assigned to Intern. Business Machines Corp. [Cl. 271-62.] The supply stack may be replenished without halting the feeding from the top of the stack.

Wolter, Harry A., and Bushey, Thomas N. **Charcoal settling conveyor.** U. S. pat. 2,989,090. Filed April 18, 1958. 14 claims. Assigned to Diamond Natl. Corp. [Cl. 141-12.] The charcoal is settled into molded pulp containers by the action of the conveyor.

Wurman, Morris L. **Display container for cigars.** U. S. pat. 2,989,174. Filed April 16, 1958. 1 claim. Assigned to Bayuk Cigars Inc. [Cl. 206-44.]

Zeitter, Charles R. **Bottle carrier.** U. S. pat. 2,989,211. Filed May 1, 1959. 2 claims. Assigned to Am. Box Board Co. [Cl. 220-112.] This is a paperboard carrier for a single bottle.

June 27, 1961

Briskey, John F. **Record system for controlling progressive distribution of coupons.** U. S. pat. 2,990,197. Filed Oct. 17, 1955. 3 claims. [Cl. 283-63.] Booklets containing retail premium coupons are provided.

Calam, Towers Christopher, and Nixon, Ian Stewart. **Gibberellic acid manufacture.** U. S. pat. 2,990,337. Filed Aug. 29, 1958. 8 claims. Assigned to Imperial Chem. Inds. Ltd. [Cl. 195-36.]

Carrel, Ralph E. **Suction box covers.** U. S. pat. 2,990,015. Filed March 19, 1957. 1 claim. [Cl. 162-367.] A paper machine suction box cover consisting of a number of rollers is provided with improved edge-seal means.

Chu, Chien Fan. **Process of making laminates from paper impregnated with a melamine-formaldehyde resin containing a buffering agent.** U. S. pat. 2,990,312. Filed July 1, 1957. 7 claims. Assigned to The Richardson Co. [Cl. 154-138.]

De Neui, Richard P., Dickerson, Arthur C., Casey, James H., and Larsen, Walter C. **Application of tape to moving objects.** U. S. pat. 2,990,081. Filed Sept. 26, 1957. 3 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 216-21.] Lengths of pressure-sensitive tape are adhered to a moving sheet of waxed paper.

Duffin, Earle Ryan. **Multi-ply paper sacks.** U. S. pat. 2,990,102. Filed Aug. 25, 1958. 4 claims. Assigned to The Bowater Research and Devt. Co. Ltd. [Cl. 229-55.]

Erickson, Harold E., Nelson, Norman E., Nelson, Charles V., and Schubert, Dale L. **Mat handling method and apparatus.** U. S. pat. 2,989,774. Filed March 21, 1957. 5 claims. Assigned to Industrial Devt. Co. [Cl. 18-4.] A wood-particle board mat is prepressed and edge-trimmed.

Gillam, Edward D. **Packages.** U. S. pat. 2,990,056. Filed Feb. 17, 1959. 7 claims. [Cl. 206-45.13.] This is a hinged lid display carton for jars or the like.

Groth, Fred A. **Packaging process.** U. S. pat. 2,989,827. Filed Aug. 15, 1956. 4 claims. Assigned to Union Carbide Corp. [Cl. 53-22.] A skin packaging process is provided.

Hitt, Jonnie Lee. **Package for sterile hypodermic needles.** U. S. pat. 2,990,059. Filed June 16, 1958. 2 claims. [Cl. 206-63.2.] The package is a paper packet.

Hornbostel, Lloyd. **Pressure gland for tail transfer.** U. S. pat. 2,990,014. Filed Jan. 23, 1959. 4 claims. Assigned to Beloit Iron Works. [Cl. 162-307.] A paper machine is provided with means for transferring the tail of a paper web from the wire to the first press felt.

Hughes, Patrick H. **Cigarette residue and ash dispersal device.** U. S. pat. 2,990,055. Filed Jan. 30, 1955. 2 claims. [Cl. 206-38.] A paperboard ashtray is provided for attachment to a cigarette pack.

Kimbrough, Charles A. **Collator.** U. S. pat. 2,990,174. Filed April 18, 1958. 2 claims. [Cl. 271-88.]

Klein, Elias, Stanonis, David J., and Harbrink, Pieter. **Production of strong rot-resistant benzyl cellulose fibers.** U. S. pat. 2,990,234. Filed March 13, 1959. 6 claims. Assigned to U. S. Sec. of Agr. [Cl. 8-120.]

Kramer, Joseph. **Folding box construction.** U. S. pat. 2,990,098. Filed April 16, 1954. 7 claims. Assigned to Diamond Natl. Corp. [Cl. 229-32.] Improved means are provided to hold the box walls in erected condition.

Leach, Alva L. **Log bunk.** U. S. pat. 2,990,192. File March 2, 1959. 6 claims. [Cl. 280-145.]

Leitzel, Ammon M. **Pulp molding method and apparatus.** U. S. pat. 2,990,314. Filed Oct. 2, 1956. 6 claims. Assigned to Pacific Pulp Molding Co. [Cl. 162-220.]

Mead, Harry A., and Slagel, Lamont. **Bag for milk and the like.** U. S. pat. 2,990,101. Filed May 1, 1959. 10 claims. Assigned to Dairy Containers, Inc. [Cl. 229-53.] Milk is packaged in a polyethylene bag which is enclosed in an outer carton.

Pacsu, Eugene, and Schwenker, Robert F., Jr. **Afterglow suppressing cellulose derivatives.** U. S. pat. 2,990,233. Filed Dec. 31, 1956. 6 claims. Assigned to Textile Research Inst. [Cl. 8-116.] Paper and other cellulosic materials are flameproofed.

Pacsu, Eugene, and Schwenker, Robert F., Jr. **Flame resistant cellulose derivatives.** U. S. pat. 2,990,232. Filed Dec. 31, 1956. 10 claims. Assigned to Textile Research Inst. [Cl. 8-116.] Paper and other cellulosic materials are flameproofed.

Polglase, Burton C., Jr. **Printing machine register control.** U. S. pat. 2,989,918. Filed Nov. 13, 1956. 10 claims. [Cl. 101-248.]

Rance, Herbert F., Baggallay, Merrik-Burrell, and Robinson, William F. E. **Paper making machines.** U. S. pat. 2,990,013. Filed June 22, 1955. 10 claims. Assigned to Bertrams Ltd. [Cl. 162-307.] Means are provided to transfer the web from the forming wire to a traveling felt.

Randak, Edward F. **Disposable ash receiver.** U. S. pat. 2,990,100. Filed May 2, 1958. 4 claims. [Cl. 229-53.] A paper packet is provided for receiving cigarette ashes.

Remer, Robert K. **Method and apparatus for slitting paper webs.** U. S. pat. 2,989,882. Filed Sept. 11, 1956. 14 claims. Assigned to Tribune Co. [Cl. 83-13.]

Roth, Curt B. **Adhesive cement for plastics.** U. S. pat. 2,990,290. Filed March 27, 1958. 13 claims. Assigned to General Aniline & Film Corp. [Cl. 106-186.] Cellulose nitrate is used.

Ryder, Fred A. **Collapsible carton.** U. S. pat. 2,990,099 Filed April 17, 1957. 2 claims. Assigned to Chicago Carton Co. [Cl. 229-39.] An automatic bottom carton is formed on a standard straight-line machine.

Sabine, Hale J. **Composite sound absorber.** U. S. pat. 2,990,027. Filed July 11, 1957. 5 claims. Assigned to The Celotex Corp. [Cl. 181-33.] An acoustical panel is made of perforated hardboard adhered in spaced areas to a paper backing.

Shepherd, Ridgley G., Jr. **Heat transfer.** U. S. pat. 2,990,311. Filed Jan. 9, 1956. 14 claims. Assigned to Dennison Mfg. Co. [Cl. 154-95.] A paper-backed heat transfer is provided for labeling plastic film.

Sowers, George H., and Colesworthy, Edward H. **Method and apparatus for processing fibrous material.** U. S. pat. 2,990,004. Filed July 12, 1956. 6 claims. Assigned to Johns-Manville Fiber Glass Inc. [Cl. 154-29.] A bonded nonwoven fiber web is formed.

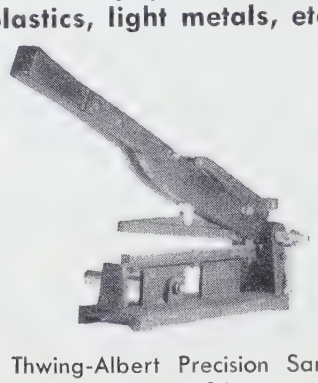
Strayer, Arthur C. **Paper board storage file.** U. S. pat. 2,990,083. Filed June 17, 1960. 5 claims. [Cl. 220-97.]

Thompson, George V. **Box assembly.** U. S. pat. 2,990,097. Filed Feb. 6, 1958. 5 claims. Assigned to Chicago Carton Co. [Cl. 229-20.] A carton for gloves or the like, having an inner portion sliding within an outer portion, is provided.

Torre, Thomas P., and Delaney, John P. **Lifting means for receptacle.** U. S. pat. 2,990,095. Filed March 5, 1957. 6 claims. Assigned to Crown Zellerbach Corp. [Cl. 229-14.] An easily lifted elongated shipping carton for rolled rugs is provided.

THWING-ALBERT PRECISION SAMPLE CUTTERS

ideal for tissues, paper, paperboard, foils, plastics, light metals, etc.



The use of Thwing-Albert Precision Sample Cutters eliminates the major cause of inaccurate tests.

Strips are cut with clean, sharp edges of the exact width, parallel throughout the entire length, free from nicks and uncut or pulled fibers.

Prepares sample strips quickly and accurately.

Hold down prevents material buckling away from, or being drawn unevenly into knives.

Available in any width from $^1/_8$ inch to 3 inches.

More Thwing-Albert Precision Cutters are in paper laboratories than any other make.

THWING-ALBERT INSTRUMENT COMPANY

5383 Pulaski Avenue Philadelphia 44, U.S.A.

#177

Wilcox, William H. **Carton opening apparatus and method.** U. S. pat. 2,989,903. Filed July 30, 1958. 16 claims. Assigned to Fibreboard Paper Prods. Corp. [Cl. 93-53.]

The following patents were received later than those of the same issue date and have accumulated over the last quarter.

Jan. 5, 1960

Heller, John H. **Method and apparatus for continuous measurement of moisture.** U. S. pat. 2,920,206. Filed Aug. 31, 1954. 12 claims. [Cl. 250-83.6.] The moisture content of a moving web of paper or pulp is measured.

May 3, 1960

Arnold, Lawrence F., and Jones, John F. **Adhesive composition comprising starch, maleic anhydride tripolymer and hydrolyzed polyacrylonitrile.** U. S. pat. 2,935,484. Filed April 3, 1957. 4 claims. Assigned to B. F. Goodrich Co. [Cl. 260-17.4.] The adhesive is for use in corrugated board or bag making.

Nov. 8, 1960

Leupold, Ernst O., and Zorn, Hermann. **Process for preparing vinyl-phosphonic-acid-bis-(β-chlorethyl)-ester.** U. S. pat. 2,959,609. Filed Nov. 6, 1956. 5 claims. Assigned to Farbwerke Hoechst AG. vormals Meister Lucius & Bruning. [Cl. 260-461.] The ester is of use in flameproofing paper.

Nov. 15, 1960

O'Brien, Joseph L. **Dialkylphosphatoalkyl vinyl sulfides.** U. S. pat. 2,960,523. Filed Dec. 19, 1957. 6 claims. Assigned to Rohm & Haas Co. 6 claims. [Cl. 260-461.] These are flameproofing agents for textiles and paper.

Nov. 22, 1960

Clancy, John J., Poole, Alton B., and Wells, Robert C. **Positive printing, pressure-sensitive material and method of making it.** U. S. pat. 2,961,334. Filed June 4, 1957. 16 claims. Assigned to Arthur D. Little, Inc. [Cl. 117-36.] This is a coated paper upon which marks may be made by application of pressure, without use of carbon paper or other marking medium.

Nov. 29, 1960

Lindstrom, Mary D., and Barkhuff, Raymond A., Jr. **Production of acrylate interpolymer aqueous latices.** U. S. pat. 2,962,465. Filed Jan. 22, 1958. 8 claims. Assigned to Monsanto Chem. Co. [Cl. 260-29.6.] This is a paper coating binder.

Trubey, Philip W. **Production of precipitated calcium carbonate.** U. S. pat. 2,962,350. Filed Dec. 3, 1957. 3 claims. Assigned to Aluminum Labs. Ltd. [Cl. 23-66.] The product is of use in papermaking.

Dec. 13, 1960

Chenicek, Joseph A., and Cox, William L. **Production of a concentrate of dimethyl ethers of 5-alkylpyrogallols.** U. S. pat. 2,964,569. Filed Nov. 29, 1956. 4 claims. Assigned to Universal Oil Prods. Co. [Cl. 260-613.] The products are produced from wood tar distillate.

Hall, George E., Jr. **Production of precipitated calcium carbonate.** U. S. pat. 2,964,382. Filed April 4, 1958. 14 claims. Assigned to Wyandotte Chemicals Corp. [Cl. 23-66.] The product is of use in coating paper.

Jan. 17, 1961

Smith, Frederick R. **Colorimetric gas sampler-analyzer.** U. S. pat. 2,968,536. Filed Feb. 6, 1957. 4 claims. Assigned to Am. Viscose Corp. [Cl. 23-254.] This is for use in measuring the carbon disulfide in the atmosphere of rayon and cellophane mills.

Jan. 24, 1961

Kaufman, John J., and Templin, Philip R. **Process of preventing the separation of polyethylene and wax comprising the addition of water.** U. S. pat. 2,969,340. Filed May 9, 1958. 2 claims. Assigned to Gulf Research & Devt. Co. [Cl. 260-28.5.] A stable wax-polyethylene composition for coating paper is provided.

Feb. 7, 1961

James, George M. **Method of purifying dilute sodium sulfate solution.** U. S. pat. 2,970,890. Filed Aug. 23, 1957. 2 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 23-121.] This is a recovery process for use in the manufacture of regenerated cellulose sponges.

Leclercq, René, and Colle, Jean. **Aqueous emulsion containing organosilicon resin and a titanium derivative, process for making same, and process of using same.** U. S. pat. 2,970,976. Filed March 18, 1957. 3 claims. Assigned to Union Chimique Belge, S.A. [Cl. 260-29.2.] This is a waterproofing composition for paper.

Feb. 14, 1961

Arledter, Hanns F. **Synthetic fiber paper and process for producing the same.** U. S. pat. 2,971,877. Filed March 5, 1956. 13 claims. Assigned to Hurlbut Paper Co. [Cl. 162-101.]

Feb. 28, 1961

Berke, Eugene A., and Jahn, Robert G. **Preparation of coated articles using gellable aqueous cationic polymer coating compositions and printing inks.** U. S. pat. 2,973,285. Filed Dec. 31, 1958. 4 claims. Assigned to The Dow Chem. Co. [Cl. 117-106.] A method is provided for coating or printing paper so that the product may be rolled or stacked without setoff.

March 14, 1961

Reifers, Richard F. **Egg case packing.** U. S. pat. 2,974,789. Filed Dec. 4, 1957. 3 claims. Assigned to Diamond Natl. Corp. [Cl. 206-65.] Cartons are arranged in an egg case.

March 21, 1961

Milne, David T. **Continuous reaction vessel.** U. S. pat. 2,976,131. Filed Feb. 20, 1958. 5 claims. Assigned to Am. Viscose Corp. [Cl. 23-285.] Alkali cellulose and ethylene oxide are continuously reacted.

Pahl, Walter H., Sandholtz, Willis A., Elerts, Nicholas R., and Goggin, Richard E. **Gummed paper.** U. S. pat. 2,976,178. Filed April 22, 1957. 10 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-122.] This is a remoistenable sealing tape for cartons.

Precast Clay Coating

A New Process and a New Product

FRANK D. BERGSTEIN

In this new process, a clay/adhesive composition is applied to a metal surface, dried, and then transferred intact onto the base sheet which has been first coated with a film of adhesive. The process has many advantages including fast drying, simplicity, adaptability to on or off machine coating and ability to coat a wide variety of base stocks.

In 1948 The Interstate Folding Box Co., after 37 years as an independent converter of cartons, started up a six-cylinder 100-in. trim boxboard mill at Miamisburg, Ohio. Once the operation there was running well, we started investigating clay coating equipment.

In the early 1950's the use of clay coated boards for folding cartons and protective packages was increasing rapidly, and the use of bleached kraft paperboard, both uncoated and coated, was making inroads into the use of conventional cylinder paperboard.

It seemed to us that there was not any great advantage in being just one more mill with conventional on-machine clay coating, particularly with the quality of the bleached kraft coated sheets improving rapidly. On the other hand, it did appear that there was no single development that we could make which could be of more use in the whole field of boxboard or packaging than a really improved clay coating method and product. Consequently, we decided not to adopt any of the existing methods and to try to develop a radically improved boxboard coating . . . in short, to obtain, if possible, a super clay coated sheet over a low cost base stock, in an on-machine operation.

Although we are a small company, in certain respects we seemed, to ourselves, well qualified for such an investigation—firstly, we had operated for years many types of coating equipment, laminators, hot melt, and waxing machines, etc.; further, we had a well equipped machine shop and a development laboratory. And, finally, our company had a long history of patented developments in the fields of packaging machinery, protective packages, laminations, etc.

Our starting point on clay coating was that the ideal place to do the coating was after the sheet is completely made and calendered. Another premise was that the ideal way to get maximum opacity was to have all the coating on the surface of the sheet. And a third consideration was that cast coating was undoubtedly that method offering the highest quality. A transfer coating appeared to be a way to meet the above conditions, and we had for many years been experimenting with this method of coating. From these different considerations the conception of what we now call "precast clay coating" evolved, the new concept being that, if it were possible to apply a clay/adhesive composition of normal mineral/binder ratio to a metal surface, dry it, and then transfer it intact onto boxboard, we could gain many of our objectives.

At first glance it would seem almost impossible to effect such a transfer since a normal clay/binder composition is in the range of 85 parts mineral pigment and only 15 parts binder and the resultant layer is very frangible, weak, and brittle and cannot be handled like a web or film.

We discovered that it was possible to do this if the boxboard was first coated with a film of adhesive which was tempered to just the right degree of tackiness and had the proper moisture content. We further found, after much experimentation, that it was not only possible to transfer a clay layer from metal to paper intact; but, even further, it was possible to transfer it and retain any surface characteristics of the casting surface inclusive of high gloss mirror finish. And, finally, we found it was possible to repeat this process over and over again on the same casting surface.

After considerable work we got the lab technique down to accurately controlled, fully reproducible conditions. We regularly checked these lab sheets for opacity, printability, gloss, folding, and the other tests for coated board. The lab sheets were outstanding in all these qualities, and we knew we had an interesting new product.

We were next faced with the decision as to whether to build a continuously operating lab machine or jump right to a production unit. We decided on the latter course and in our own machine shop designed and built a 46-in. coater to carry out our new precast coating method. Needless to say, the machine was modified many, many times to constantly improve its operation, and there was a tremendous amount of work involved in correlating the results from our lab sheets to the 46-in. production unit.

LARGE-SCALE RESEARCH PROGRAM

The research involved in this program has been extensive. To give you an idea, we formulated over 5000 clay coatings, and over 2000 adhesive formulations. We made over 14,000 lab draw-downs which were evaluated and are on file in our laboratory storage section. Finally, we made over 300 full-scale machine trials and most of these, in turn, were divided into A, B, C, etc., in which all conditions were held constant except for one change.

SUCCESS OF OPERATION

Our first production unit has been in operation for several years or more and we have run a large number of commercial jobs ranging in caliper from 0.015 to over 0.030, in printing from simple line work to six color jobs with fine 133-line screen process, and in quantity from small runs of 5 tons up to runs of 50 tons and over. The operation is highly efficient and trouble-free, with very low spoilage, and we are able to coat widely different types of stock with a minimum of machine adjustments. We coat right over splices, slime spots, and even holes in the sheet with no interruption to the operations.

The basic steps of the process are as follows: a mineral pigment-binder slurry is applied to the casting surface, such as a mirror finish drum or belt, and this layer is smoothed and dried while on the casting surface. The web to which this dried layer is to be transferred meanwhile has a thin uniform layer of adhesive applied to it which is brought to a controlled consistency. This tacky adhesively coated web is then pressed against the dried clay layer, and then the web is lead away from the casting surface with the clay layer firmly laminated or bonded to the adhesive-coated web; and the casting surface returns to the clay application pan for re-application of the slurry and a repetition of the cycle.

FRANK D. BERGSTEIN, Executive Vice-President, The Interstate Folding Box Co., Middletown, Ohio.

ADVANTAGES OF PROCESS

In our opinion the process and final product both offer many advantages. Here are some of the advantages, as we see them, of the new process:

1. The drying rate is exceptionally high. Since the clay layer is not associated with the paper during drying but is laid on the drum, drying is effected both from the heated drum on one side and from high velocity air on the opposite side of the layer; and, there is no paper which has become wet, to redry. We long ago achieved a drying rate of 9 lb. per sq. ft. per hr., and we have dried the coating at the rate of 150 f.p.m. drying 7 lb. of coating per 1000 sq. ft. with the coating only being exposed to heat for 5 lineal ft.

2. This efficient drying means that the equipment is compact and that relatively high speeds, certainly for cast coating, are possible.

3. Since the clay is dried separately from the web, the thickness of the web or its imperviousness have no effect on the speed of the operation.

4. We have a simplified rheology condition in that we are always coating our clay on the same surface regardless of the nature of the web to be coated; and, having established the necessary conditions for coating the casting surface, we never have to change them from hour to hour or from day to day.

5. We fully utilize all the coating material in that none of it soaks into the board or paper.

6. Because of the excellent coverage we get, problems in the base stock are simplified; and, dirt or asphalt spots, for example, do not show through at all.

7. We have an absolutely uniform coating layer due to the fact that one side of the clay layer is mirror smooth, being against the drum or belt, and the other side of the layer is contacted by smoothing means. In short, we smooth both sides of our clay layer, which is not possible in any of the standard methods in which the clay is applied directly to the web. We have found that a 1-mil coating is an excellent thickness for cylinder boxboard and because of our ability to smooth both sides *we can say with complete confidence* that our coating *is* 1-mil thick!

8. The process is adapted to both on and off machine coating.

9. Since we add no water to the base stock in applying the clay layer, and only a small amount of water in applying our adhesive, there is no problem is slowing up on- or off-machine coating because of added water.

10. Finally, as far as the process aspect is concerned, this precast method is an almost universal method—paper, paperboard, impervious webs, metal, cloth, foil, etc., almost any kind of web, can be coated, and we have coated a wide variety of them in actual practice.

ADVANTAGES OF END PRODUCT—"GLOSSCOAT" BOARD

As to the advantages of the end product itself, which we call "Glosscoat" board:

1. The brightness is 82 or more whether the coating is applied over chipboard, kraft colored board, or white patent coated.

2. The gloss is generally equal to conventional cast coated sheets—in the range of 15 or more on a Gardiner gloss meter at 20° angle.

3. Due mainly, we believe, to the fact that all the binder is retained in the clay layer and none soaks into the sheet, plus the help the adhesive layer below the coating adds, the folding properties are very good. We have coated boxboard finishing 0.037 and it bent well with no fracturing. We feel that we actually improve the bender of the base sheet with this process.

4. The nonfade properties are superior, as indicated by the fact that we show no trace of fade after 48 hr. exposure in an Atlas Fadeometer.

5. We get ideal conditions for the manufacture of colored clay coated end products. Because of the high opacity, small amounts of color go far and the final color is substantially independent of the base stock. Our ten standard colors of Glosscoat also pass the 48-hr. test with no fade.

6. Printability is excellent, as can well be expected when you consider that the clay layer is absolutely uniform in thickness, and there are no fibers sticking through the clay and no thin spots in the clay coating. We have printed 133-line screen four-color process work on letterpress with no fill-in of the dots, and beautiful results. Ink consumption is low, and letterpress inks, even heavy solids, dry to the touch in half an hour.

7. As proof that there are no fibers projecting through, finished Glosscoat board is, in flat condition, absolutely grease-proof even though the ratios of clay to binder are normal. When the standard TAPPI sand and turpentine test is applied to the coated side of the sheet, there is no penetration, the turpentine evaporating before it penetrates.

COSTS

The cost of the finished coating is higher than conventional clay coatings due, in part, to the fact that we are putting on such a heavy coating, and also due to the extra cost of the film of glue underneath the coating. However, the added coating cost is greatly compensated for (and in some cases completely compensated for) by the fact that lower grade base stocks can be used. Also, the final result is so superior to conventional clays that it puts this sheet in a premium price bracket.

PATENT PROTECTION

The precast clay coating method and the final product which has been discussed are fully covered by United States patent no. 2,934,467, and other patents pending; also foreign patents issued and pending. We worked very closely with our patent counsel throughout the many years of development and operation of this program, keeping them fully advised at all stages of our progress from process, machine and article standpoints, sending a steady flow of samples over the years as improvements came, and working with our attorneys to file patents as patentable developments came forth.

The Interstate Folding Box Co. and certain of its personnel between them have over 250 patents in the field of packaging and allied arts, and considerable background in licensing programs. All steps to insure complete patent coverage of this extensive program were carefully undertaken at all stages.

As can well be appreciated that we have acquired over the years a great deal of know-how and experience which has been extremely helpful to us in the improvement of our equipment and the efficiency of the operation.

FUTURE

We are now starting up our new 100 in. wide on-machine precast clay coater (Glosscoat coater) which was built for us by the Dilts Div. of The Black-Clawson Co. under a license agreement, and was designed in cooperation with our personnel. This new unit, which will coat the full width of our six-cylinder board machine and will coat the full range of our weights and grades from 0.015 to 0.036 and over, is, we believe, the world's first on-machine cast coating operation!

We feel that this new on-machine unit will be a graphic demonstration of the many advantages of this new process and the new coated products that precast clay coating makes possible.

Presented at the 12th Coating Conference of the Technical Association of the Pulp and Paper Industry held in Buffalo, N.Y., May 8–20, 1961.

The author would like to acknowledge the support and encouragement of his brother, Robert Bergstein, during the many trying years of this development until success was achieved, and the zeal, technical skill and cooperation displayed by his co-workers, Robert Nerenberg, director of research; Al Kleingers, chief chemist; and Leonard Back, chief engineer.

The Examination of Boxboard Samples for Trace Quantities of Heavy Metals

WALTER F. WEISS and EDWARD C. STIVERS

An analytical examination for trace quantities of mercury, lead, cadmium, antimony, and arsenic in boxboard is described. The digestion scheme and the choice of suitable controls were found to be important. Of the five metals of concern, lead was found to be present at the highest level.

THE application of previously established analytical techniques to the examination of boxboard samples has been investigated, specifically for trace quantities of mercury, lead, cadmium, antimony, and arsenic. In many instances, boxboard comes in contact with edible substances or its precursors. The levels of these metals in boxboard from normal production runs was therefore of obvious concern.

Two problems were encountered in the determination of these metals. The first was to develop a digestion technique for the boxboard so as to preclude any loss of volatile mercury and the obtaining of a homogeneous solution from which accurate estimates of the levels of the heavy metals could be made without interference by occlusion or binding. The second was the selection of suitable controls both to demonstrate recovery and compensate for high blanks.

The determinations of mercury, lead, and cadmium were finally effected using dithizone reagent in chloroform measuring the dithizone metal complex with a spectrophotometer. Antimony was determined via the formation of the Rhodamine B complex in an ether phase. A semiquantitative method was employed for arsenic.

EXPERIMENTAL

Samples of boxboard were cut up into small squares and placed in a large Kjeldahl digestion flask. Fifteen milliliters of concentrated nitric acid per 10 g. of boxboard was added and the resulting mixture allowed to digest on the steam bath for 6 to 8 hr. Then 10 ml. of concentrated sulfuric acid per 10 g. of boxboard was added and the digestion flask heated with a very low flame. Digestion was continued with gentle heating until the volume of roughly 25 ml. was reached. We found it important not to overheat at this step because of the loss of mercury vapor. Final digestion was accomplished with 70% perchloric acid; a pale yellow solution was obtained. The digestion solution was filtered and diluted 10:1 with water.

The general method used for the determination of mercury is described by Cooper, Sullivan and Winkler (*1–3*). An aliquot of the digestion mixture was adjusted to pH 2 and extracted with the strong dithizone in chloroform. The residual acid solution was set aside for the lead determination. The chloroform solution was then extracted with dilute ammonium hydroxide and the chloroform layer examined spectrophotometrically using the Beckman DU.

The acid by-product of the mercury determination was adjusted to pH 10 with strong aqueous ammonia. Sodium cyanide was added and the lead extracted with a dilute solution of dithizone in chloroform. We found at least four extractions were necessary in order to obtain quantitative recovery of the lead from the solution. Chloroform extracts were diluted with known volumes and examined.

Saltzman's method (*4*) was used for the determination of cadmium. An aliquot of the original digestion mixture was treated with strong sodium hydroxide and sodium cyanide. The alkaline solution was extracted with the strong solution of dithizone in chloroform. A chloroform extract was separated and treated with a 2% tartaric acid solution. Again a minimum of four extractions was required in order to recover the cadmium quantitatively.

For determination of antimony, the method used was that described by Ward and Latkin (*5*). A portion of the digestion mixture was extracted with di-isopropyl ether. The ether extract was washed with 1 *M* HCl solution containing 2% hydroxylamine. The ether solution was then treated with 1 *M* HCl solution of Rhodamine B to form the desired complex in the ether phase. The ether solution was then examined spectrophotometrically.

Because of interferences, whose nature remained somewhat uncertain, in boxboard samples, we could not determine arsenic using the blue arseno-molybdate ion. Consequently, a more sensitive semiquantitative modified Guzeit (*6*) method was employed. Arsenic-free zinc granules were added to an acid solution of digestion solution in the presence of ferric and stannic ions. The arsenic is converted to arsene gas. The gas is swept away from the flask by the hydrogen produced by the reaction of the acid and zinc. The gas reacts with mercuric chloride treated paper to give a brown to yellow stain which is proportional in length to the quantity of arsenic. This procedure is estimated to detect $^1/_{10}$ p.p.m. of arsenic.

Table I. Estimation of Mercury, Food Grade 2, News
CCA's 0.020 white patent coated news

	A *Hg added before digestion, γ*	*B*[c] *Hg found after digestion, γ*	*B-A*[a] *Hg found in sample, p.p.m.*
Sample	0	0.10	0.10
Sample	0	0.09	0.09
Sample	1.00	1.11[d]	0.11
Control[b]	1.00	0.87	..

[a] Average quantity for sample: 0.10 p.p.m. of mercury.
[b] Digested without added paper.
[c] These numbers represent quantities of mercury in excess of ten times the "zero" or blank values of the method.
[d] Mercury determined in the presence of added lead, arsenic, antimony and cadmium equivalent to 1 γ each per gram sample.

Table II. Estimation of Mercury, Food Grade 2, Manila
CCA's 0.022 white patent coated Manila

	A *Hg added before digestion, γ*	*B*[c] *Hg found after digestion, γ*	*B-A*[a] *Hg found in sample, p.p.m.*
Sample	0	0.07	0.07
Sample	0	0.06	0.06
Sample	0	0.08	0.08
Control[b]	1.00	1.05[d]	..

[a] Average quantity for sample: 0.07 p.p.m. of mercury.
[b] Digested without added paper.
[c] These numbers represent quantities of mercury in excess of ten times the "zero" or blank values of the method.
[d] Mercury determined in the presence of added lead.

RESULTS AND DISCUSSION

Table I is a typical mercury determination. Samples were examined as received and with added amounts of mercury. In addition, a control was run. In this column is recorded

Table III. Estimation of Lead, Food Grade 2, News
CCA's 0.020 white patent coated news

	A *Pb added before digestion, γ*	*B*[c] *Pb found after digestion, γ*	*B-A*[a] *Pb bound in sample p.p.m.*
Sample	0	2.3	2.3
Sample	0	2.1	2.1
Sample	0	3.4	3.4
Sample	1.00	4.5[d]	3.5
Control[b]	1.00	1.3[d]	..

[a] Average quantity for sample: 2.8 p.p.m. lead.
[b] Digested without added paper.
[c] These numbers represent quantities of lead in excess of ten times the "zero" or blank values of the method.
[d] Lead determined in the presence of added mercury, arsenic, antimony, and cadmium equivalent to 1 γ each per gram sample.

WALTER F. WEISS and EDWARD C. STIVERS, Arthur D. Little, Inc., Cambridge, Mass.

Table IV. Estimation of Arsenic

		A As added before digestion, γ	B As found after digestion, γ	B-A[a] As found in sample, p.p.m.
Food grade 2, news[d]	Sample	0	<0.05[c]	<0.05
	Sample	0	<0.05[c]	<0.05
	Control[b]	2.0	2.0	..
Food grade 2, manila[e]	Sample	0	<0.05[c]	<0.05
	Sample	0	<0.05[c]	<0.05
	Control[b]	2.0	2.5	..
Food grade 3[f]	Sample	0	<0.5[c]	<0.05
	Sample	0	<0.5[c]	<0.05
Newsboard[g]	Sample	0	<0.05[c]	<0.05
	Sample	0	<0.05[c]	<0.05
	Control[b]	2.0	1.5	..

[a] Average quantity for all samples of board: <0.05 p.p.m. of arsenic (beyond sensitivity of the determination).
[b] Digested without added paper.
[c] 0.1 γ of arsenic is readily detectable by this method.
[d] CAA's 0.020 white patent coated news.
[e] CCA's 0.022 white patent coated manila.
[f] CCA's 0.018 white patent coated solid manila.
[g] MC's 0.017 white patent coated newsboard.

the mercury found after digestion corrected for the blank. Generally speaking, the blanks were about 10% of the values found here. The control represents a digestion without added paper. In the third column is tabulated the net mercury found in the sample. We felt much more confident about our results because of the consistency of the results on samples to which known quantities of mercury had been added. These particular results were obtained on food grade 2 news boxboard. Similarly our results for food grade 2 manila are shown in Table II. Again we found roughly the same level of mercury.

The results for lead in food grade 2 news is shown in Table III. The average quantity of lead in this material was about 2.8 p.p.m. Significantly higher certainly than the mercury level.

As mentioned previously, the level of arsenic in boxboard was only semiquantitatively estimated. Our observations with this method are shown in Table IV. In this case the controls were digested without added paper for we could not detect any arsenic in the various samples of boxboard within the limits of detectability.

Table V is a summary of our findings. For food grade 3 under the lead heading, no lead could be detected and this

Table V. Summary of Results

Heavy metal, p.p.m. of "as received" boxboard

Code[b]	Mercury	Lead	Cadmium	Antimony	Arsenic
Food grade 2, news	0.10	2.8	<0.004[a]	0.23	<0.05[a]
Food grade 2, manila	0.07	3.6	0.28	0.10	<0.05[a]
Food grade 3	0.20	<0.002[a]	0.13	0.18	<0.05[a]
Newsboard	0.10	3.2	0.09	0.08	<0.05[a]

[a] Not detectable by procedure employed.
[b] Food grade 2, news is CCA's 0.020 white patent coated news. Food grade 2, manila is CCA's 0.022 white patent coated manila. Food grade 3 is CCA's 0.018 white patent coated solid manila, newsboard is Michigan carton's 0.017 white patent coated newsboard.

figure represents our estimated lower limit of detectability of lead. Similarly, food grade 2 under the cadmium heading, our lower limit of detectability is 4 parts per billion.

LITERATURE CITED

1. Cooper, S. S., and Sullivan, M. L., *Anal. Chem.* 23: 613 (1951).
2. Winkler, W. O., *A.O.A.C.* 18: 638 (1935).
3. Winkler, W. O., *A.O.A.C.* 21: 220 (1938).
4. Saltzman, B. E., *Anal. Chem.* 25: 493 (1953).
5. Ward, F. N., and Latkin, H. S., *Anal. Chem.* 26: 1168 (1954).
6. Scott, W. W., "Standard Methods of Chemical Analysis," D. Van Nostrand Co., Inc., Vol. 1, 5th Ed., 1939.

Received Aug. 25, 1961. Presented at the 12th Testing Conference of the Technical Association of the Pulp and Paper Industry held in Montreal, Que., Aug. 15–17, 1961.

The authors wish to thank the Boxboard Research & Development Association, Kalamazoo, Mich., for the financial support of this work.

Defining and Solving Toxicological Problems Related to the Paper and Pulp Industry by Use of Radioisotope Techniques

FRANK J. DOMINGUES and D. H. ANDERSEN

The paper illustrates how (1) isotopes can determine whether a problem exists or not as indicated by the BHT transfer studies in packaging materials and, (2) how direct metabolism studies can afford supplementary information to the usual toxicity program and in certain specific cases substitutes for such a program. Also discussed is the newer approach to rapid assessment of toxicity, using isotopes as indicators of when normal metabolism has been interfered with by the addition of foreign additives to a normal dietary regime.

In 1958, the Food Additives Amendment to the Food and Drug Law was enacted which prohibits the use in food of additives which have not been adequately tested to establish their safety. The law makes mandatory the pretesting of new additives by the manufacturer and authorizes the use of beneficial additives at levels which are safe. Many of the problems arising from this legislation have been solved, however, the extremely broad applicability of the law to the food and allied industries, such as paper, was not anticipated at the time of its passage. Interpretations and actions by the Government during the past year have done much to clarify many sections of the law and have provided the related industries with a basic framework for operation under the law. Since 1960, only a few of the thousand or more recognized food additives have been added to the Federal Food and Drug Act of 1938.

A provision was enacted into the original amendment which called for a one-year extension for use of an additive where it has been shown there is no immediate danger to public health and that efforts are being made by the manufacturer to gather the required information for preparation of a petition. Through this provision, the continued use of a great number of food additives have been allowed. A number of lists have been submitted, principally by trade groups, requesting that all of the materials used in the manufacture of particular products be granted a blanket extension, until sufficient information can be made available to pass on a petition. Many industries which had not previously considered themselves subject to the Food and Drug Administration regulations are now under jurisdiction of the law, such as the paper and pulp industry.

It was rather obvious that by March 31, 1961, there were thousands of additives requiring clearance but which did not materialize due to the nature of the additive, insufficient evidence of its toxicity, and the delay in processing the petitions due to insufficient or limited toxicological data.

The need for effective and safe food additives has been described in detail by experts in the fields of food research, chemical research, and toxicological research. The number of food additives currently used, either as processing chemicals or intentional additives, is high. The flavor industry alone has submitted to the FDA a list of over 700 materials which have been used in compounding flavors for foods. Pesticide residues on raw food commodities are also a major problem. Over 1900 exemptions and tolerances have been established by the FDA.

The problem of great importance to our national health and welfare is that of determining whether or not food additives are *in fact safe.*

Current procedures for establishing the probable safety

Frank J. Domingues, and D. H. Andersen, General Measurements, Inc. Division Precision Scientific Co., Garnerville, N. Y.

of a food additive are both long and costly. Furthermore, the results of the current testing procedures are not always conclusive with respect to determining the safety of food additives. It is not unusual for the food, chemical, and related industries to invest thousands of dollars in toxicological research on a potential food additive, only to find that the material is not suitable for use. The magnitude of the problem is such that serious and immediate attention should be given to the development of improved techniques for testing the safety of food additives. Radioisotopes are particularly well-suited for this area of research. They afford the ability to follow dynamic, complex, and submicroscopic body processes, and they are extremely sensitive. Techniques based on the use of radioisotopes would certainly benefit the toxicologists in their immediate and urgent problems of: (1) dose-effect relationships, (2) time-concentration-effect relationships, (3) absorption, distribution, metabolism, and fate of chemicals introduced into the body, (4) relationship between chemical constitution and biological action, and (5) the mechanisms by which chemical molecules introduced into living material react with the molecules comprising the cells of living things.

Research related to the development of improved screening techniques, based on radioisotopes, will be discussed later.

The first application of isotopes can be made in defining the problem. Does the problem really exist is the first question that can be answered. After it has been established that there is indeed a problem, we can turn our attention to the methods by which isotopes can help us solve the problem. There are two approaches to the solution of these problems by the use of radioisotopes. The first is by use of the "direct technique" and the second is the use of the "indirect technique." Each of these will be discussed briefly with examples of precedence in which isotopes have saved the manufacturer money, both in terms of financial outlay and savings in market time. The application of isotopes to defining a problem is especially important to industries in the paper and pulp field which are manufacturing containers for holding various types of foods. Several years ago, it had been demonstrated that butyl hydroxy toluene (BHT) was an extremely effective antioxidant for protection against rancidity of fats in cereal products. Unfortunately, the levels of this class of antioxidant which the FDA would allow in these cereal products was very low. The level of BHT allowable is predetermined by the percentage of fat which the product contained. Since most cereal products have very low fat concentrations, the allowable BHT in p.p.m. is exceedingly low; so low, that the usual analytical techniques for determining the concentration of BHT are not very satisfactory. In an effort to circumvent direct addition of BHT to the product, the antioxidants were incorporated into the packaging material itself and it was demonstrated that antioxidative activity and protection could still be achieved. Since this does not constitute a direct addition to the food product itself, perhaps some of the manufacturers thought that they could successfully circumvent the restrictions of the law regulating the use of BHT in food products. Many theories were proposed as to the role and mechanism of rancidity protection afforded by this indirect application. The FDA, not too concerned with theory, wanted to know whether the container manufacturers could show that the BHT was not being transferred to the product anyway and if so, what residuals were left in the product. In other words, is there a problem. Again the anticipated levels of transfer, if any, could not be satisfactorily analyzed for using the conventional analytical techniques. The analytical problem is further complicated because in cereal products, there are interfering substances which also reduce the color reagent. The use of radioisotopes in this instance was an ideal application. Several package liners, including glassine, aluminum foil laminates, and wax coated manila board were prepared with the addition of known amounts of radioactive BHT to the wax used in making these liners. These samples were stored under controlled conditions and both the loss of BHT from the liners and the transfer of BHT to the cereal product were studied against time. Figures serve to show the rates of transfer of BHT to the product. It was shown that indeed BHT is transferred to the product in different concentrations.

The "direct" method consists of synthesizing the compound of interest, tagging it with carbon-14 at appropriate positions within the molecule, and feeding this to experimental animals. The absorption, utilization, excretion, and storage, if any, of a compound is at its very least, important supplemental information to be used with the standard acute, 90 day, and chronic feeding studies. For example, if a compound shows a high absorption, low excretion, high storage, and is not metabolized by the body, an increasing accumulation of this compound at best must be considered suspicious. On the other hand, if a compound is not absorbed at all and is excreted quantitatively, the chance of this compound being innocuous are very good. Again if the compound is absorbed and is metabolized by well known intermediate metabolic pathways, the probability that the compound is innocuous is also very good, but none of these direct approach findings can be used exclusively as a substitute for conventional feeding studies to show evidence that the compound should be granted a petition for in-food use.

There are occasionally a few exceptions in which studies of the direct type can be substituted completely for whole animal feeding studies. Precedence for this acceptance could come about in certain cases where individual respective portions of a molecule have been independently studied by approved techniques and accepted for in-food use. Propylene glycol di stearate (PGDS) represents an example of this type of compound. The toxicity of PGDS and stearic acid both have been well worked out and accepted levels established by the FDA. Where one wishes to use a compound such as PGDS, it can be synthesized tagging both the PG moiety and the stearic acid moiety independently. The absorption and excretion can be established and furthermore, the rate of hydrolysis of PGDS to free PG and stearic acid can be determined. Both the portal blood system and the lymphatic system can be analyzed for evidence of recombination if any, and to what extent this recombination takes place. If the evidence shows that PGDS acts metabolically as if it were administered as PG and stearic acid this can be taken as evidence to show that PGDS is no more toxic than either PG or stearic acid. Thus in-food use limits can be established for this compound without the necessity of prolonged 2-year feeding studies.

Another approach, the indirect approach, potentially has much more promise and can operate with less limitations and restrictions than the direct technique. The indirect technique basically has a fundamental simple hypothesis. It is as follows: any compound which significantly and sufficiently disturbs the normal healthy metabolic status quo must be viewed with suspicion. The advantage of this technique is that one need not undergo a difficult and, in some cases, impossible synthesis of every new compound to be studied. The success of the technique depends upon the correct analysis and interpretation of normal metabolic processes, and by using isotopes to determine what these normal metabolic reactions are. The introduction of a new compound to the control animal's dietary regime will, if toxic, produce a significant change in the normal metabolic processes. The success of the technique depends upon the discovery of a known specific reaction or group of reactions which will respond to the inherent degree of toxicity that the compound may have independent of the toxicological site and mode of action.

Much of this work was instituted at the General Foods Research Center and this work is currently still going on. The first set of reactions studied were those involved in car-

bohydrate metabolism. Since carbohydrates are used chiefly for source of energy and are very rapidly turned over, it seemed logical to investigate this class of metabolism initially. Glucose being a common carbohydrate found in the dietary regime was chosen as the substrate of choice. Since carbon dioxide is an end product of oxidative reactions, it was chosen to be measured. In addition, the measurement of both radioactive and nonradioactive carbon dioxide can be made easily today by the use of automatic accurate instrumentation. This has facilitated the studies in this program. Much of the data gained to date have been primarily of a tentative nature, but sufficient correlation has been established so as to lend encouragement to the continued support of this approach to rapidly defining whether a compound is toxic or not. The presumption that normal metabolic processes must be disturbed early in a toxic stress syndrome and continued for some period of time before tissue changes are sufficient to produce pathology gives an inherent rapidity and early detection to this technique. This has important economic consequences to the manufacturers of additives, both directly to be used in food and indirectly as in packaging materials.

Some additional analyses of metabolic reactions to the carbon dioxide excretion patterns should certainly involve analysis of blood and urine, studies of metabolic pools and metabolic products at the potential organ level, effect of toxic agents on the uptake of selected radioactive substrates at the cellular level, studies on the effect of toxic agents on the utilization of these radioactive substrates by isolated mitochondrial fractions, studies of animal response to these toxic agents as measured by changes in steroid balance, and the study of species differences which should ultimately include study with humans leading to a toxicity assessment on man himself.

Received Aug. 25, 1961. Presented at the 12th Testing Conference of the Technical Association of the Pulp and Paper Industry held in Montreal, Que., Aug. 15–17, 1961.

Newsprint Quality Control

VINCENT N. DEFELICE

The problems of newsprint quality control are discussed, followed by a description of the newsprint quality control program at St. Croix Paper Co. and some thoughts and hopes for the future.

The objective of newsprint quality control is to provide uniform paper at low cost which will run well and print well in a newspaper pressroom and provide a suitable medium for display of printed matter and photographs.

As newsprint is mass-produced on high speed machines, newsprint quality control must also be geared to high speed. Unfortunately, there are many problems which prevent this ideal from being reached. These include: (1) sampling, (2) testing, (3) specifications, (4) use of test results, and (5) lack of good instrumentation.

These problems can be visualized by considering a paper tester tearing a tiny sample from a 5-ton reel of paper, sticking it in his back pocket, sauntering through the machine room, perhaps having a smoke in the smoking area in the locker room, and finally arriving at a small dusty lab where he proceeds to run a burst test, caliper, and smoothness, all of which he dutifully records on a lab report form which no one sees but the technical director the next day.

Meanwhile, the back-tender has torn an approximately correct sized sample from the slab off the top of the reel, which is headed for the hydropulper anyway, dutifully weighs it, records the weight as 32.0, and sits back on his bench, proud that he has done his duty.

Some hours later, the paper tester, having paid a call at the other machines on his beat, returns for another sample to test. He may bring a slip with him showing the tests on the last reel or he may even record the test on a log sheet at the machine. The more advanced tester may simply record the test without bothering to waste time testing. The effect on the operation of the machine is about the same in either case.

SAMPLING

At present, the very best job of sampling that can be done is to take a sample after the outer slab has been torn off the reel, immediately place it in a protective container—for example, a plastic bag and get it to the laboratory as rapidly as possible. At St. Croix, we plan to have machine personnel do the sampling, and send the protected sample to the laboratory immediately via a pneumatic tube where it will be tested after a very short conditioning period in a laboratory under controlled conditions of temperature and humidity. There will be no tester with the paper sample in his back pocket.

TESTING

Testing is a two edged sword. What shall we test and how shall we test it? We are faced with the unhappy fact that the properties desired by our customer in the product which we send him are not easily tested with presently available instruments. The two properties that are basic to all pressrooms are runability and printability. Add to that the "appearance" of the sheet and certain general properties which have a bearing on one or more or the preceding and we have the properties we wish to control.

RUNABILITY

The pressroom break record is of great importance to the printer. News must be "hot" or it is stale. In this day of television and radio, the newspaper cannot compete by providing last week's news. Therefore, the time of printing an edition must be kept at the bare minimum. Newsprint that will not run safely at high speed is of no use to the large daily newspapers who use the greatest share of our product. I suppose that most newspapers would prefer a break record of 0 breaks per 100 rolls but suspect that they might settle for 3 breaks per 100 rolls. Consider the amount of paper involved in three breaks per 100 rolls. It is as minute a percentage of the total quantity of paper in the rolls as is the tiny bit of paper we seriously test and announce as representative of the entire lot. It is probable that no present available strength test measured on the quantity of sample that we can test and still have paper to sell gives a good indication of potential pressroom performance.

Despite this, we at St. Croix measure cross direction tearing resistance very faithfully and conscientiously and control our sulfite percentage by the tear test. Other mills use bursting strength while still others use tensile. A step beyond the average strength is the use of a series of tests across the web with the idea of finding "weak spots."

The tear test is a good measure of sulfite percentage and since newsprint requires a certain percentage of sulfite in order to run at all in the pressroom, the test is an aid in controlling uniform sulfite percentage which is important in maintaining uniform newsprint properties.

PRINTABILITY

Recently I heard a publisher asked whether he wanted runability or printability. He answered by asking whether he should cut off his right arm or his left arm. If the printed newspaper does not have eye appeal, the advertisements will go to other communication media. Without advertising there would be no newspapers at the present low cost.

Vincent N. DeFelice, Control Superintendent, St. Croix Paper Co., Woodland, Me.

Newsprint is not the only component of the printed newspaper. Ink, both kind and quantity, pressure, and environment are all factors in the look of the printed page. These factors vary from pressroom to pressroom and may even vary in the same pressroom from night to day or in different seasons of the year.

At St. Croix, we run three tests which bear on printability. The most important of these is smoothness in that it is used as a direct control at the paper machine. As applied to a particular machine of a particular mill, smoothness changes are a good indication of changes in printability but smoothness is not a good means of comparison of machines in different mills or even different machines in the same mill. It is also important to note that newsprint can be too smooth as well as too rough and we have therefore established control limits for smoothness.

As an approach to a direct measure of printability we used the Larocque test, by which we make a solid black print from a lightweight magnesium plate on a Vandercook proof press under controlled printing pressure and ink film. A per cent printability is determined as specified by Larocque (*1, 2*). We also use the prints for visual comparisons and examination for defects.

To back up the first two tests, we determine oil absorption using a Vanceometer. This test, although not a control test, has been very useful in characterizing the absorptivity of our newsprint.

There are other aspects of printability besides those we directly measure, above. These include ink smear and show-through. These can be measured on a proof press print using a thicker ink film than we use for the Larocque test. However, smoothness provides a good indication of potential ink smear and we use the Bausch and Lomb opacimeter to measure printing opacity as a measure of show-through.

APPEARANCE

The appearance of the unprinted sheet is becoming of great importance. The former red-yellow shade (sometimes called rather enthusiastically "cream") is giving way to a more blue-green shade which has a flatter GERS curve and is "whiter." As a sequel to this, publishers are becoming interested in what they call a "brighter" sheet (but actually a whiter sheet) and are becoming somewhat less than enthusiastic about the shive and bark dotted sheet which was the newsprint of not too many years ago.

The properties involved are generally subjective in nature and their measurement on a mill control basis is subject to considerable controversy. At St. Croix, we measure brightness, color, and dirt. Of these, standard brightness is on the most solid technical basis but, unfortunately, it is of little significance in judging the appearance of newsprint and is greatly misunderstood. The most technically sound approach to the problem of evaluating appearance would be the use of a General Electric recording spectrophotometer to establish color coordinates in the C. I. E. system. However, at least at present, this is not practical. At the St. Croix we have compromised and use a three filter instrument to measure reflectances, converting the results to the a, b, and L values of the modified Adams coordinate system. As an additional step, we have used one of Hunter's formulas for whiteness, (L-3b), and report whiteness as well (*3*).

The acceptance and understanding of "whiteness" has been very good. We have used it in setting color specifications and have found it to be a closer approach to what the non-technical men mean when they say brightness.

In color control, we have found that the mill color men can readily understand the a and b values and now adjust dye based on those values.

An appearance characteristic of great importance is cleanliness. Unfortunately, cleanliness of newsprint is not necessarily a function of equivalent black area as determined by the PAPPRIC dirt counter or by use of the TAPPI dirt evaluation method. At St. Croix, we have established visual dirt standards, against which we check our sheet.

GENERAL PROPERTIES

Finally, there are several general properties, which bear on one or more of the foregoing. These include basis weight, moisture, and caliper. We measure basis weight by the time-honored method of tearing a sample using a template to get the correct area and weighing the sample on a scale calibrated in pounds per 24 × 36—500 ream. We measure caliper by use of an electrically operated micrometer.

Both basis weight and caliper are being measured in the industry by profilers installed both on and off the machine. There is a good deal of promise in this type of application as applied to both measurement and control.

Moisture is an extremely difficult property to measure in newsprint. At St. Croix, we have gone full circle from oven drying to capacitance-type instruments back to oven drying, then to the use of an electric hot plate or speed drier, and finally we installed a moisture recorder on one of our machines. We have high hopes for this installation but still need considerable time to give it a good evaluation.

The most sensitive part of a newsprint moisture test is the original sampling! We have had very good instruments which told us what the moisture content was of the paper being tested as it was being tested, but they did not tell what the moisture content was in the reel and that is what we wanted to know.

SPECIFICATIONS

Having arrived at certain properties we feel should be investigated and having arrived at tests which will give us some clue as to how these properties are varying, we must now know what the limits should be on the test results.

After considerable correspondence, a few years ago, I came to the conclusion that about the only newsprint specification one could be sure of was that basis weight was supposed to be 32.0 lb. This was a nice island of fact in the morass of uncertainty. Unfortunately, this pleasant island also sank below the mud when I couldn't find out the allowable variation about the 32 pounds.

The problem of specifications, therefore has two aspects: (1) what should the *average* value be and (2) what is the allowable or practical variation around that average?

We established all of our specifications, except two, both for the average and the allowable limits by considering two factors: (1) the competition and (2) our own variation.

We set up a procedure by which we obtained and tested samples of our competitor's newsprint. After a sufficient period elapsed, we simply ranked the competitor's tests and picked the test value in the rank where we felt St. Croix should be. This was the average for which we were aiming.

We determined the allowable variation from the normal variation in individual St. Croix newsprint tests.

The two tests which did not come under this procedure were basis weight and moisture. In the case of basis weight, we already had an average (32.0 lb.), but did determine our allowable variation by analysis of actual basis weight variation. In the case of moisture, we did not feel that the tests on competitive paper had any significance so selected a moisture value in a more arbitrary manner. The variation was, however, determined for our normal variation.

The mechanical procedure outlined above is fairly routine but the specifications in this stage are only recommended specs. Next, the Control Department superintendent, armed with the above recommended specs, sits down with the sales manager, general manager, production manager, and paper mill superintendent and the final specifications are hammered out.

The objective is to have specifications which are a necessary quality of newsprint and which will help sell the product

but can be met in the mill. It is vital that a test which is out of specification be capable of meeting the spec. If *all* tests are poor, soon no one can distinguish between the tests which require action and those that don't. In bringing the test into range, more work may be necessary than the papermaker can do. Corrective action may be mechanical or even engineering.

At St. Croix, press roll changes, calender stack changes, wet end mechanical changes, and even costly equipment purchases have resulted from efforts to meet specifications.

We have reached the point where all of our qualities have met specifications at one time or another, although not always all at the same time.

Review of these specifications is regularly scheduled four times per year, but specifications are sometimes changed between regular reviews. The three factors which prompt spec changes are: (1) changes in industry pattern, (2) change in position of St. Croix with respect to the industry, and (3) reduction in variation of St. Croix tests.

Our terminology for specifications divides individual test data into three groups: (1) poor, (2) good, and (3) very good. Any individual test which is in the poor range has not met specifications. Over a period of a week or more, any quality which has 5% or more individual tests in the poor range has not met specifications. This is arbitrary, but has its foundation in the manner that normal variation was used in establishing the range of "good" around the average value.

It is desired to have all tests in the good range. Tests which land in the very good range may indicate that the cost has increased more than it should have, as in the case of tear, or it may indicate that the test value is in a region where it may not be acceptable to certain customers, as in the case of roughness or it may indicate that the paper *is* very good without question of doubt as in the case of basis weight. The nomenclature used is subject to some controversy, but we feel that it is more dramatic and more meaningful to the operators to call out of specification paper "poor" rather than a more neutral term such as "fair."

Specifications have been set on the following properties: basis weight, moisture, Bendsten roughness (wire side), tear (cross machine direction), dirt, brightness, per cent printability (wire side), TAPPI opacity, printing opacity, and color.

USE OF TEST RESULTS

Assuming perfect sampling and testing and perfect specifications, the program would fall very flat if nothing came from the test results except data on a lab report.

Results are used in four ways: (1) immediate report by tester, (2) daily production meeting, (3) weekly report, and (4) monthly report.

At the present time, tests are recorded in three different locations so that the tour foreman can see a test no matter where his duties take him. Color data are tested and recorded at the location where color is controlled so that immediate action can be taken to correct color variations. To dramatize out of range tests, they are recorded in red and the tour foreman is handed a slip reporting that the test is out of range. Our plans call for a Telautograph system so that when we do have our new laboratory, results will be flashed immediately to the paper machine with no running around by the tester. Connected with the Telautograph will be a red light and possibly a siren or a gong to announce that an out of specification test has been taken.

At our daily production meeting, the control superintendent reports as to how well specifications were met on the preceding day. The tour foreman with a string of red tests may be in trouble.

A weekly summary is issued which serves the purpose of focusing on the necessity for mechanical changes or repairs. This report is issued about two days before the weekly maintenance meeting so that there is ample time to consider the implications of the quality report.

The monthly quality report is discussed at a meeting of al paper machine tour foreman as well as management an technical control. The gist of it is a review as to how wel we met the challenge of our specifications. Conditions no under the control of the tour foreman and not susceptible t normal maintenance are brought to light. A comparison with prior months is made. In addition, the position of St Croix in respect to competitive mills is reviewed. Newsprin from these mills is passed around the table so that the foreme can see what our competitors are doing.

These weekly and monthly reports are also read by ou sales department and by our company president. A hig per cent poor on a quality may very well lead to some pertinen inquiries by these gentlemen.

LACK OF GOOD INSTRUMENTATION

In discussing the various properties which the custome desires in newsprint, I gave the St. Croix's solutions, but I hop I did not give the impression that we are satisfied with ou solutions. We are not, and I wish to appeal to the imagina tion and ingenuity of the instrument makers in this audienc to devise instruments which if used correctly will tell us whe our paper is good or bad. Any of the fields described earlier are wide open for better testing equipment.

To really show you what I think the newsprint industry needs, let me take you into the future. Before we go there let us remember the tester with the crumpled up sample i his back pocket, sauntering around the paper machines. Wha have I done with him thus far? Well, he is no longer saun tering, and his sample is now in pretty good shape. But he i still there, and he is getting a tiny sample from an immens lot of paper and his tests are still terribly indirect. Besides if we want any kind of control, he is likely to have a few companions just as busy as he is and if we want to make a respectable profit for the stockholders, we can't have too many of these noncontributing individuals around.

So let's get rid of all the testers by making one assumptio and tailoring our thinking to that assumption.

All properties of the sheet, the runability, the printability the appearance, the moisture, the basis weight, and the caliper, etc. shall be measured on the moving web using equip ment installed on the paper machine.

Before we wonder how we are going to measure the runa bility on a moving web, let's look at a logical sequal to thi statement.

The measuring devices will also function as controllers to (1) bring out of limit tests back into range, and (2) reject paper outside of limits acceptable to the customer until the proper test values are reached.

Obviously the limits as set in (1) would not be as broad as those set in (2). Moreover, there should be no condition (2) except on startups.

Consider the advantages of this system. There would be no testers. There would be no "poor" paper to dwell on in weekly and monthly reports. There would be no questio as to whether the little portion of the reel tested has any re semblance to the paper being shipped. One roll of paper should be exactly like every other roll as paper as far as physical specs are concerned, as all the off-specification paper has gone to broke.

The question of testing runability on a moving web should be a very interesting one, especially since it does not appear that we know how to predict runability by our present destructive methods yet. But let me throw out two thoughts. First, if Dr. Larocque is right and weak spots have an important effect on runability, would not an optical method be as good a way to locate a weak spot as a strength test? Secondly, could not load-elongation data be obtained on a moving web which is just as valuable as the tensile strength at rupture, which is our normal test at present? Assuming that our sheet is going to be uniform across the web thanks to all of the control devices you instrument makers are going to

invent, could not a dynamic load-elongation test be made on a small side-run roll during the winding operation?

Perhaps these trial balloons I have tossed at you will go into orbit and never reach the earth again but I will have accomplished my purpose if I have caused some of you to turn your brains and energy towards solving the problems of newsprint quality control.

LITERATURE CITED

1. Larocque, G., Axelrod, B., and Clark S., *Pulp and Paper Mag. Can.* 52, No. 3: 166–174 (1951).
2. Prince, R. W., *Tappi* 42, No. 5: 418–24 (1959).
3. Hunter, R. S., *J. Opt. Soc. Am.* 50, No. 1: 44–48 (1960).

Received Aug. 25, 1961. Presented at the 12th Testing Conference of the Technical Association of the Pulp and Paper Industry, Montreal, Que., Aug. 15–17, 1961.

Development and Application of the Kopparfors Lining

RAY A. MENGES, ARNE AHLSTROM, AND I. OLSSON

A major advance has been made in the design of digester linings. Existing digesters may now be lined in the field with high alloy stainless steel—without welding the stainless lining to the carbon steel shell. In 1951, after considerable development work, the entire brick lining of a 250 cu. m. sulfite digester in Sweden was removed and replaced with a thin skin of high alloy stainless steel. The Swedish inventors used an unorthodox approach in installing the lining, now called the Kopparfors lining. The stainless steel sheets were not welded to the carbon steel shell. Instead, stainless sheet was welded to stainless sheet with the liner anchored to the digester at a few key points. In order to hold this stainless sheathing flush to the wall of the digester, a vacuum was maintained between the lining and the wall. To date, 25 digesters, 5 hot acid tanks, and 5 digester domes have been lined with the Kopparfors lining in eight countries: Sweden, Austria, Germany, Finland, Morocco, South Africa, Japan, and the United States. The sizes of the digesters range from 80 to 350 cu. m. The sizes of the acid accumulators range from 300 c. to 600 cu. m.

One of the toughest problems confronting the sulfite pulping industry is that of materials of construction. The powerful reducing action of sulfurous acid in the digesters at the elevated operating temperatures and pressures creates havoc with ordinary steel. From the very inception of the sulfite process some 100 years ago until the present, the industry has continued experimentation with various types of digester linings. Today, the problem is tending to become more aggravated due to shorter cycle periods and a swing away from insoluble bases to soluble bases.

During the period following the invention of the sulfite process, Tilghman, in 1886, used a loose lead lining (*1*). The need to repair the lead lining after every cook was ended about 10 years later when a single course of brick was used to hold the loose lead lining in place. It was not until the late 1890's that the first all-brick lined sulfite digester was put into service in Scandinavia.

Today over 95% (*1*) of the sulfite digesters are brick-lined. In spite of the many improvements in brick lining which may have been made in the past 60 years, the inherent drawbacks of brick linings still plague the industry. Three of the basic disadvantages of brick linings in digesters are:

1. Relatively short and unpredictable life compared to the total life of the digester shell.
2. Necessity of continuous maintenance even with carefully controlled digester operation.
3. Inflexibility of pulping techniques.

The sulfite pulp industry has experienced wide variation in the life of ceramic brick face linings, the most common type brick used today. References in the literature cite an average life for ceramic face linings ranging from 2 to 3 years (*2*) to 8 years even with continuous maintenance (*1*).

The cause for the early mechanical failure of face brick linings and for the unpredictable life of a lining is reasonably well understood. The excessive compressive stress arising from the differential thermal expansion between the brick lining and the steel shell results in mechanical failure of the brick (*1*, *2*). Ceramic brick used in digesters has a thermal coefficient about one half that of mild steel (0.0000031 in. per in. per °F. versus 0.0000063). Because of the insulating property of the brick, the temperature differential between the shell and the brick may be as high as 150°F. at the height of a cook (*3*). The net result of such a temperature differential is a high compressive stress of approximately 4000 p.s.i.g. set up in the brick because the brick expands considerably more than the steel (*2*). A stress of this magnitude has been found to cause failure to 14% of ceramic bricks tested by the Northwest Experiment Station of the U. S. Bureau of Mines (*2*).

With the recent trend in changes of bases in the sulfite industry, further problems have to be faced. Now a relatively impervious barrier must be used between the face brick and the backing brick in order to prevent deep and free penetration of the cooking liquor when operating with soluble bases (*1*).

With the advent in the past few years of low carbon (E.L.C.) grades of stainless steel, there became available an excellent material of construction for the sulfite industry. These E.L.C. stainless steels have excellent corrosion resistance to the powerful reducing action of hot sulfurous acid in the digester. In new digester installations, E.L.C. stainless steel clad has made it possible for the pulping industry to expect a digester to last 30 years with essentially no maintenance (*4*).

Serious corrosion problems, however, have arisen in attempting to use these same stainless steels in existing sulfite digesters. The problem stems not from corrosion due to the cooking liquor alone, but from a combination of stress and corrosive cooking liquor. There are strong indications, particularly evident in the light of recent developments, that the corrosion of these alloy materials is due to two factors:

1. Stress due to the thermal expansion differential between carbon steel and stainless steel and the action of the cooking liquor combine to cause corrosion.
2. Carbon migration from the steel shell into the stainless steel welds.

Stainless steel has a thermal expansion coefficient considerably higher than mild steel. For the type 316 and 317 austenitic stainless steels, the thermal expansion is 160% of that of mild steel. Thus, when stainless steel strips are welded directly onto digester walls, or are spot welded, severe compressive stresses are set up at elevated cooking temperatures. These stresses, combined with the corrosive atmosphere of the digesters, result in a deterioration of the stainless steel sheet and welds. The welds are subject to further corrosion due to the migration of carbon from the mild steel of the digester shell to the stainless welded joints.

Two techniques are reported in the literature for the application of stainless steel for the lining of existing digesters. Weld rod overlay of stainless in thicknesses ranging from 80 to 100 mills has been used in the kraft pulping field. Relatively high installed costs of from $14 to $27 per sq. ft. are reported (*5*). One mill has recently relined all sulfite digesters with stainless overlay, but no results are reported as yet. Molten metal spray of stainless steel is reported to have given irregular results (*5*).

Ray A. Menges, Vulcan-Cincinnati, Inc., Cincinnati, Ohio; Arne Ahlstrom, and I. Olsson, AB Nordstroms Linbanor, Stockholm, Sweden.

The initial cost of a stainless steel-clad digester is appreciably higher than the initial cost of a stainless steel liner to replace an existing brick liner. However, the problems encountered in the installation of a stainless liner have not previously been successfully solved until the first commercial application of the Kopparfors lining in 1951.

THE KOPPARFORS LINING

In Sweden a technique has been developed for lining existing digesters with stainless steel to overcome the problems of stress corrosion and carbon migration. Digesters already 40 years old have been lined with type 316 E.L.C. and 317 E.L.C., thus extending the expected digester life by an additional 30 years.

The Hammarby mill of Kopparfors AB, located in Storvik, Sweden, was faced with serious damage to the sulfite digester brick linings after World War II. During the war, a special dissolving pulp was produced to make possible the efficient recovery of spent liquor for alcohol production. As a result of several years of operation of this type, the brick digester linings were considerably damaged, and the damage was increased by attempts to operate at maximum capacity.

The managing director of Kopparfors AB, S. E. Holgersson, started a development study of the physical and chemical properties of stainless steel sheeting to replace the damaged brick linings. The new postwar stainless steels demonstrated excellent corrosion-resistant properties in handling sulfite liquors and shortly thereafter stainless steel was used to replace piping in the mill.

In 1947, Mr. Holgersson decided to replace the brick lining in the half spherical dome of the no. 4 digester with stainless steel sheet. The 150 cu. m. digester dome was lined with 4 mm. (equivalent to 9 gage or 0.156 in.) sheet using techniques which had been developed since the start of the program. On April 26, 1947, the digester with its stainless-lined dome was put into service. After 13 years, it still is in good condition.

Shortly thereafter, barrel and the bottom half-spherical section of the digester was lined with stainless steel sheet. It was here that Kopparfors lining technique was first applied. Because of the wide thermal condition occurring in the cone, a new process was developed. Instead of weldnig the stainless sheet to the digester wall, the lining was essentially free. In addition, a special expansion joint was designed and a vacuum system set up between the shell and the lining in order to prevent a collapse of the lining during evacuation of cooks. A detection system was incorporated in the vacuum liner in order to warn of possible leaks.

In 1951, the Hammarby mill completely lined a 250 cu. m. digester following the new procedure. Only at key points was the lining attached to the digester shell. The vacuum system held the lining flush to the wall. By 1955, all seven of the Hammarby mill digesters were lined with this new patented process (*6*), later to be known as the Kopparfors lining. Since that time the specially lined digesters have been in continuous use with but very little maintenance.

INSTALLATION TECHNIQUES

Many hurdles had to be surmounted before the Kopparfors lining became a successful reality. First, it was necessary to find a stainless steel capable of withstanding the severe corrosive atmosphere of the digester cooking cycle. Provision for expansion had to be designed into the lining to take up the longitudinal elongation and the girth-wise elongation to prevent stress corrosion. After this, there was the practical problem of installing optimum size sheets around nozzles, rivets, butt straps, and fish plates of the digester. Outside of the digester a vacuum system with a leak detector warning system had to be installed.

Type of Stainless Steel

For the severe chemical conditions existing in sulfite digesters, it has been found necessary to use the lowest carbo content 18-8 stainless steels or the equivalent in stabilize stainless steels containing titanium, columbium, and tanta lum, which are added for the purpose of combining with th carbon to form the carbide compound. In many Europea applications of the Kopparfors lining, the stabilized stainles steels have been generally used, principally because the E.L C. grades have not been available there.

The Avesta Iron and Steel Works of Avesta, Sweden, firm having the exclusive rights to the Kopparfors lining i Sweden, has provided a considerable amount of the stainles steel for Kopparfors installations. Avesta had carried ou extensive studies on the 18-8 stainless steels. In a report c June 7, 1955, by this firm to the Fourth World Petroleu Congress (*7*), it is indicated that stainless steel of the E.L.C grade containing a maximum of 0.03% carbon is superior t the stabilized types. The corrosion resistance, as well as th welding properties and finish of E.L.C. grade are shown to b superior to the titanium and columbium stabilized grades c stainless steel. Comparative tests in boiling 65% nitric aci (Huey's test) gave the following average results from a larg number of tests:

Grade	*Weight loss, gm./sq. m. hr.*
18–8 Carbon max. 0.05%	0.3
18–8 Stabilized with columbium	0.5
18–8 Stabilized with titanium	1.0

It is of particular importance in the application of th Kopparfors lining that the stainless steel meet rigid specifica tions in regard to its analysis. Only stainless with know mill analysis is used.

Studies on the stainless steel Kopparfors linings in Swede indicate that the corrosion is nil after 10 years of service. I is therefore expected that the life of a Kopparfors lining in sulfite digester will be in excess of 30 years.

Two of the pulp mills using the Kopparfors lining hav chlorides present in the digesters because of salt water-born wood. In one of these mills employing an efficient recover system for the spent cooking liquor the chloride concentratio reaches the relatively high level of 4500 parts of chloride pe million parts of cooking liquor. In the other mill the chlorid level is considerably lower because the spent liquor is dis charged to the sea.

Despite the presence of chlorides, the Kopparfors lining ha proved satisfactory at both pulp mills. In the plant wher the chlorides are 4500 p.p.m. the Kopparfors lining has bee in service in the dome of one digester for $4^1/_2$ yr. The othe five domes were installed later on. In Sweden, where th chloride level is lower because the spent calcium liquor is dis charged to the sea, the Kopparfors lining has been in service fo $3^1/_2$ yr. It is noteworthy that this Swedish mill has converte from calcium to sodium base. With a recovery plant fo the spent liquor, the chloride level will rise to about the leve of the other mill.

Digester Expansion

One of the most difficult problems which had to be over come in the development of the Kopparfors lining was due t the differential in thermal elongation between the carbo steel shell and the stainless steel lining.

The carbon steel shell of a typical digester will expan longitudinally about 1.0 in. as compared with 1.7 in. for th stainless steel lining. The elongation due to pressure at 10 p.s.i. is only $^1/_{20}$ of that due to temperature.

In order to compensate for the greater expansion of th stainless steel over that of carbon steel, special expansio joints were developed. In the longitudinal direction, bellows type joints were incorporated into the liner at different points Generally one expansion joint for the dome, one expansio joint for the cone, and one or more expansion joints in th straight side were used. For the expansion circumferentially

the extra elongation of the stainless steel is compensated for by the space existing between the lining and the shell. Thus the Kopparfors liner is allowed to expand and contract substantially free of the carbon shell during the cooking cycle.

In 1958 Carl Canzler of Dueren, Germany, having a license agreement to design and install the Kopparfors liner in Germany, made an exhaustive study of the contraction and expansion problems that were and would occur in the operation of a digester containing a Kopparfors liner. The result of this study was a lasting contribution to the further development of the Kopparfors liner. A patent application covering this development was filed by Heinrich Bock and Oskar Lenhard, and the technique developed was passed along to all licensees for the Kopparfors liner. As a result of the work carried out by Carl Canzler, it was possible to install steel disks on a triangular pitch pattern which were welded direct to the shell of the digester. These disks were approximately 80 mm. diam., 3 mm. thick, and have a 150 mm. dished radius.

The installation of these disks provided the needed differential surface area, which permitted the lining to contract and expand in an overall even-flowing motion and eliminated the necessity of providing expansion joints in the lining proper. In eliminating the bellows type of expansion joint, Carl Canzler succeeded in removing the one item that could cause sagging of the lining and/or mechanical failure due to the folding action in the expansion bellows brought about by the expansion and contraction of the liner.

Nozzles

The Kopparfors lining is installed so that free expansion and contraction of the liner is possible. It is not welded directly onto the carbon steel shell, except at the top and bottom manholes. At the nozzles inside the digester, the liner is welded onto stainless steel rings, which are formed and welded around the nozzle liners. This technique provides for freedom of movement of the nozzle liners.

Butt Straps and Fish Plates

The Avesta Iron and Steel Co. of Sweden have developed a special installation technique which prevents possible stress corrosion of the liner at the edges of the butt straps. A relatively smooth surface in the cone and dome of digesters may be obtained by filling the area between fish plates with carbon steel fillers. This technique also prevents possible stress corrosion of the liner due to contact with the raised fish plates.

Rivets

Present practice is to install the Kopparfors liner over the rivet buttons.

Size of Sheet

Ideally, the sheets used in the Kopparfors lining should be as large as possible in order to reduce the amount of welding required and thus reduce the manpower for installation. Three different methods have been used to get the sheets inside the digester. The sheet may be entered through the top manhole, or through a slit cut out of the sides of the digester, or the bottom cone may be dropped out.

Vacuum System

The vacuum maintained between the shell and liner holds the Kopparfors lining in place against the shell during the blowing and washing of the digester. The rapid release of internal pressure and the thermal differences resulting from these operations would tend to pull and stress the liner out of place without this application of the vacuum.

SUMMARY

Advantages of Kopparfors Lining

The Kopparfors lining has demonstrated its superiority over the brick type digester lining in sulfite pulping in many ways. These are the principal advantages:

1. An increase in digester capacity because of the larger volume available in the digester. This increase in capacity will vary from 13 to 27%, depending upon the percentage of volume occupied by the courses of brick.
2. An increase in pulp production because no downtime is required for replacement of facing brick.
3. An increase in pulp production because there is no necessity for slow cooks to prevent thermal stresses in the liner.
4. An increase in the life of a digester lining from an average of about 7 to 30 yr. The 30-yr. life expectancy is based upon inspection of existing Kopparfors-lined digesters which show no corrosion after 10 yr.
5. A decrease in maintenance.
6. A clean pulp free from the contamination of broken bricks. With the elimination of brick, maintenance on the screens and stock pumps are reduced considerably.
7. Flexibility of operation. New cooking liquor bases may be used without fear of harm to lining. At the present time the Kopparfors lining is used with the following bases: calcium, ammonium, and magnesium. One of the Swedish plants using Kopparfors linings has changed over to sodium-base pulping.
8. Overall lower costs, investment and maintenance per ton of pulp. Without taking into account the profit from the extra productivity possible, the investment and maintenance cost per ton of pulp for a Kopparfors-lined digester is approximately two thirds that of a brick-lined digester.
9. The additional profit resulting from the extra tonnage obtained in one year of operation would, in most instances, pay for the Kopparfors lining installation in approximately 1 year. For this case, profit is assumed to be $20 per ton of pulp.

Economics

Significant savings combined with increased production result from the use of the Kopparfors lining. A comparative study reveals that the approximate investment and maintenance cost of a Kopparfors lining is about two thirds that of the standard ceramic brick face lining, not including the profit from the extra production.

For the development of the comparative economics of the two linings, actual cost data from a Pacific Northwest mill using ceramic brick were used. It was considered that the cost data were representative of good life expectancy for ceramic brick. This mill, using calcium base liquor, has an average life of 7 yr. for the major portion of the brick lining. The bottom cone is relined an average of every $3^1/_2$ yr. The digesters, with brick lining, have a capacity of 5400 cu. ft., and when lined with the Kopparfors lining, have a capacity of 6200 cu. ft.

Brick-lined digester	*Cost, $*	*Annual cost per digester, $ (Based on 7-yr. life)*
Replacement cost of brick facing every 7 yr.	12,000	1700
Preparation of digester—stripping and sandblasting	2,600	370
Plant manpower for removal of piping and handling bricks—550 man-hr. at $4.50/man-hr.	2,500	360
Replacement cost of brick facing for bottom cone every $3^1/_2$ yr.	2,000	570
Preparation of digester cone—stripping and sandblasting	1,000	285
Six-month check-up—25 man-hr.	115	230
Maintenance on stock pumps due to spalling of brick—labor and material per year	2,100	350
	22,315	3865

Kopparfors-lined digester	*Cost, $*	*Annual cost per digester (Based on 30-yr. life), $*
Stainless steel—316 E.L.C.—1/8 in. thick, 6200 cu. ft. digester	45,000	1500
Preparation of digester—stripping and sandblasting	5,400	180
Plant manpower for removal and reinstallation of piping—200 man-hr. at $4.50/man-hr.	900	30
Insulation of digester—installed	5,400	180
Vacuum system—installed	5,100	170
Detection system	3,600	120
Inspection	60	2
	65,460	2182

This includes a multipoint pH recorder. For each additional digester, add $700 each for materials and equipment required to connect sensing element to multipoint recorder furnished with first lining installed.

A comparison of the average downtime for the brick-lined and Kopparfors-lined digesters is as follows:

	Number of days down	*Annual days downtime per digester*
Brick lining (7-yr. life)		
New digester lining	14	2
Equivalent days lost to slow cooks	7	1
Six-month check-up 1/2 day each	7	1
Pointing up joints annually	7	1
New cone facing	7	1
	42	6
Kopparfors Lining (30-yr. life)		
New lining	30	1
Six-month check-up 1/2 day each	30	1
	60	2

Comparison of investment and maintenance cost for brick lining and Kopparfors lining over 30 years:

	Brick lining	*Kopparfors lining*
Annual pulp tonnage—6 digesters —360 days/yr., tons	162,000	162,000
Extra production schedule of 15.0% larger digester volume, tons	...	24,300
Extra production due to 4 extra production days, tons		1,860
Total	162,000 Tons	188,160 Tons
Per cent increase	...	16.1
Total cost of six digesters over 30 years, $	696,000	378,260
Unit cost of digester per ton of pulp, ¢/ton	14.3	6.8

LITERATURE CITED

1. Tucker, E. F., *Paper Trade J.* 25–30 (Oct. 21, 1957).
2. Kelley, H. J., Mainhardt, R., and Strandberg, K. G., *J. Amer. Ceramic Society* 36, No. 1: 18–26 (Jan., 1953).
3. Tucker, E. F., *Tappi* 33, No. 1: 29–32 (Jan., 1950).
4. Funk, W. H. and Wyche, E. H., *Paper Trade J.* 23–30 (May 18, 1950).
5. Hopper, E. W. and Morrison, J. B., *Tappi* 39, No. 11: 793–796 (Nov., 1956).
6. Holgersson, S. P. H. E. *et al.*, U. S. pat. (2,694,632), Nov. 16, 1954.
7. Lilljeqvist, G. and Hansen, S., Proceedings of the Fourth World Petroleum Conference, Section VII/B, Reprint 7.

Received April 19, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry held in New York, N. Y., Feb. 20–23, 1961.

Fluorescent Whitening Agents and Their Behavior in Paper Manufacture

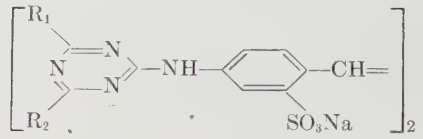
A. J. HINTON

A. J. Hinton, Imperial Chemical Industries Ltd., Dyestuffs Div., Manchester, England.

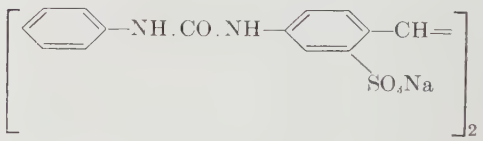
An understanding of the various factors affecting the performance of fluorescent whitening agents in paper making is essential if the most effective use is to be made of these products. The article below indicates the magnitude of the changes which may be expected under various conditions, and suggests testing methods.

The addition of optical bleaching agents (fluorescent whitening agents) to bleached pulps, to produce papers that are whiter than chemical bleaching can produce, has become standard practice, so that today white papers that do not contain optical bleach are quite rare. The paper industry has in fact become, in recent years, one of the largest consumers of fluorescent whiteners. It is not generally realized that these chemicals undergo quite complex variations in behavior according to the conditions under which they are used, and it is the purpose of this article to indicate the types of variations that might be expected, and the testing methods that can be used to detect these differences in behavior (*1*).

The two main types of optical bleaching agents used in the paper industry consist of disubstituted 4:4′-diamino 2:2′-disulfonated stilbenes, as depicted below:



Type 1



Type 2

The majority of agents belong to type 1. Careful choice of the substituents R_1 and R_2 produces agents with the desired technical performance and shade, and the sulfonate groups confer water solubility, which may be enhanced or diminished by the substituents R_1 and R_2. Reasonable water solubility is a desirable property for certain applications, for example for surface coatings and for size-press application, but high solubility is not essential in papermaking when the product may be added dry to the beater or hydropulper. Liquid products are attractive from the viewpoint of ease of handling and measuring, and their ready dispersion with the pulp is an advantage for shading at the machine chest and for continuous addition.

As a general rule, good affinity for cellulose is required, but an excessive affinity may give rise to an undesirable "silurian" (or mottled) effect. This effect will not be visible when the sheet is viewed in daylight, but under ultraviolet radiation highly fluorescent fibers will be shown up against a background of less fluorescent fibers.

The action of optical bleaching agents is well understood, and it suffices to state that the optical bleaching agent is activated by invisible ultraviolet light, and it responds by emitting a longer wavelength radiation, namely blue, visible light. This additional colored light compensates for the inherent yellowness and dullness of bleached pulps.

It is of interest to note that the products that produce red shades of white generally exhibit less fluorescence for a given

visual whiteness than products that produce blue shades of white (*2*). Therefore, the measurement of the total fluorescence of whitened papers may not give a true comparison of the relative strengths of a range of different whitening agents.

BEATER APPLICATION

The various factors affecting the performance of whitening agents in beater application are discussed below.

The first factor is the pulp itself. The better the original bleaching of the pulp, the greater will be the improvement produced by a given quantity of whitening agent. This is particularly important when producing "superwhites" or "high-whites," since a high whiteness pulp can attain a degree of whiteness that is unattainable with lower whiteness pulps using the same whitening agent.

The quality of the sizing materials is also important, since they are deposited in the pulp fibers during sizing. The aluminium sulfate should be a good-quality, iron-free alum and the rosin should be a purified, water white grade. Attention to these two factors is well worth while since they can result in economies as high as 30% of the total cost of whitening agent employed.

The most important factor is the quality of water to which the whitening agent is added. Naturally, the water should be as clean as possible, since any suspended dirt will be precipitated on to the fibers during sizing.

In some mills (probably the majority) the water in which the pulp is suspended and to which the whitening agent is added will be fresh water. In other mills, the water will be recirculated water from the machine (that is, "whitewater") and the acidity may be quite high with a pH as low as 4, depending on the type of paper produced. The former conditions are ideal for all types of whitening agents, but the latter conditions are suitable only if an acid-resistant whitening agent is employed. In addition, if it is desired to add the aluminium sulfate to the pulp before the whitening agent (as, for example, in continuous whitening), it is essential that the agent used should possess a reasonable degree of acid resistance.

All these factors must be taken into consideration in any laboratory testing, which should be designed to select the most suitable agent from the many products available. The pulp, rosin, alum, and water must all be taken from the materials used in the mill, otherwise the results obtained from laboratory testing will bear no relation to the performance of the whitening agent under all the conditions likely to be encountered in the mill.

To demonstrate the nature of the variations that may be expected, the performance of 16 well-known whitening agents has been examined by the methods given at the end of this article. The results are given in the table below.

In the first column, the letters R/B and G/B indicate respectively that the product produces a reddish-blue shade or a greenish-blue shade of white. The next portion of the table is concerned with the losses in whitening effect when whitened papers, produced under various conditions, are compared by measurement of their fluorescence in an EEL Fluorescent Light Meter.

The second column shows the loss in fluorescence on sizing the pulp with 2% rosin and 4% aluminium sulfate, added after the whitening agent. It is well known that unsized papers are whiter in appearance than sized papers produced from the same bleached pulps. This difference becomes very much more pronounced when the whiteness is enhanced by the presence of a whitening agent, and it may be concluded that this effect is due largely to the precipitation of yellow particles of rosin size on to the fibers.

This loss on sizing is considerable, and represents losses of between 25 and 40% in fluorescence. All the agents examined were similar in that they lost more than 25% fluorescence on sizing, although Fluolite RP showed a significantly lower loss than average. Three conclusions may be drawn from these results: (1) only the purest grade of rosin size should be used for whitened papers; (2) rigid control should be exercised over the addition of sizing materials in the mill since this will help to maintain steady running conditions without fluctuations from the standard shade; and (3) considerable savings in the cost of whitening will be achieved by sizing the paper as lightly as possible for the particular grade of paper being produced.

	Change in fluorescence, %				
Whitening Agent	*Effect of sizing with 2% rosin, 4% alum (unsized patterns as control)*	*Effect of adding agent to pulp suspended in acid whitewater at pH 4.5. All patterns sized 2% rosin, 4% alum (pulp suspended in tap water as control patterns)*	*Effect of addition of 4% aluminum sulfate before agent to pulp; 2% rosin after agent (patterns using normal order of addition— agent, rosin, alum — as control)*	*Effect of addition of 5% alum on unrosinated patterns (unsized patterns as control)*	*Effect of alum on solution of whitening agent*
Fluolite RP (R/B)	−26.5	− 1.5	− 1.3	+ 6.5	No precipitate
Fluolite C (G/B)	−36.0	− 8.5	−11.5	− 7.5	Yellow precipitate
Fluolite MP Liquid (G/B)	−40.5	− 7.5	−12.5	...	Yellow precipitate
Agent 1 (R/B)	−31.5	− 3.5	...	...	No precipitate
Agent 2 (R/B)	−32.0	− 4.0	+13.0	+13.5	No precipitate
Agent 3 (R/B)	−38.0	− 4.5	+ 6.5	...	No precipitate
Agent 4 (R/B)	−35.0	− 6.5	...	+19.5	No precipitate
Agent 5 (R/B)	−38.0	− 7.5	..	− 5.5	Yellow precipitate
Agent 6 (G/B)	−40.0	− 2.5	− 4.0	...	Yellow precipitate
Agent 7 (Liquid) (G/B)	−39.5	−14.0	−17.5	...	White precipitate
Agent 8 (G/B)	−39.5	−16.0	−14.5	...	Yellow precipitate
Agent 9 (G/B)	−41.0	−20.5	−33.5	−13.5	Yellow precipitate
Agent 10 (G/B)	−39.0	−23.5	−22.5	...	Yellow precipitate
Agent 11 (G/B)	−42.5	−24.0	−34.5	−29.0	Yellow precipitate
Agent 12 (Liquid) (G/B)	−37.5	−32.0	−33.5	...	Yellow precipitate
Agent 13 (G/B)	−33.0	−36.0	−33.5	−33.0	White precipitate

It has been suggested from time to time that any whitening agent that has not dyed on to the fibers by the time the aluminium sulfate is added will be precipitated by the alum, and that the color of this whitening agent/alum precipitate will play a role in the loss of effect on sizing. The last column in the table shows what happens when a solution of aluminium sulfate is added to solutions of the whitening agents. Some agents are precipitated as white or yellow solids, and others are unaffected. These results suggest that there is no connection between the color of the precipitate and the loss of whitening effect on sizing.

The results in the third column of the table should be of interest to all mills which recirculate acid whitewater to the beaters and/or hydropulpers. This column shows the loss in fluorescence when sized papers, prepared in acid white-

water (at pH 4.5), are compared with similarly sized papers prepared from fresh water. This test indicates the suitability of the agent for addition to acid whitewater.

Most of the redder-shade agents, but very few of the green-blue shade agents, exhibit satisfactory performance under these conditions. Some of the green-blue shade agents lose more than 40% fluorescence when added to pulp suspended in acid whitewater, and very few agents of this shade suffer a suitably low loss to be economical when used under these conditions. Fluolite RP was the best of all the agents tested for this property, and Fluolite C and Fluolite MP Liquid, as green-blue shade products, were considerably better than average.

When water, with aluminium sulfate added to give a pH of 4.5, is used in place of the backwater, the whiteness losses are generally, but not always, more severe than those given by whitewater (*3*).

As mentioned earlier, if it is required to add the aluminium sulfate to the pulp before addition of the whitening agent, it is essential that an acid-resistant product be used. The effect of prior addition of aluminium sulfate is shown in column four. Here again, Fluolite RP shows a high degree of acid stability.

The fifth column in this table shows the changes in fluorescence that occur when 5% aluminium sulfate is added to unsized papers. Some agents actually show an increased whitening effect on addition of the alum, while others were diminished in whitening effect. It is of interest to note that those products that did not form a precipitate with aluminium sulfate exhibited an enhanced whiteness on the addition of alum, possibly due to an added substantivity gained by complex formation with the alum, or with cationic aluminium salts.

SURFACE APPLICATION

It does not necessarily follow that a product that has been found eminently suitable for beater application will also be suitable for application to the surface of paper.

When the agent is required for whitening from an alkaline medium (for example, china clay/casein coating mix), the green-blue shade products give the most economical effect as a general rule. However, when the agent is to be applied from a neutral medium (for example, starch or gelatine solutions or coating mixes), the most suitable products are those that are unaffected by the acid reaction of paper.

USE OF SHADING DYESTUFFS

The use of shading dyestuffs, in conjunction with whitening agents, is becoming more widely accepted as a means of varying the shade of whiteness rather than relying on the inherent shade of the whitening agent. It is a fact that considerable economies in the cost of whitening paper can be achieved by the careful choice of shading dyestuffs for both beater and surface whitening. A single shading dyestuff and a single whitening agent, used together, can produce a wider range of white papers than is possible using a dozen whitening agents.

The use of a shading dyestuff is perhaps most beneficial in the production of "super-white" or "high"-white papers, in which the whitening agent is employed at a high concentration to produce its miximum whitening effect. If a shading dyestuff (for example, Methyl Violet 10B0 200 or Caledon Paper Blue RNS Powder Fine) is used at this stage, the maximum whiteness properties of the agent are enhanced considerably.

EXPERIMENTAL DETAILS

1. *Quenching Effect of Sizing*

Two and a half grams (airdry weight) bleached sulfite pulp, beaten to S.R. 40°, were suspended in 200 ml. wate and the whitening agent added from a 0.025% solution. N further additions were made for the unsized dyeings, bu for the sized dyeings additions were made of 2% rosin (on dr pulp weight) and 4% aluminium sulfate (on dry pulp weight) Time intervals of 20 min. were allowed (a) between additio of agent and addition of rosin, (b) between addition of rosi and addition of aluminium sulfate, and (c) between additio of aluminium sulfate and formation of the sheet on a hanc mold. In the case of the unsized dyeings, a time interval c 60 min. was allowed for exhausting between the additio of agent and the formation of the sheet.

The sheets were dried between white paper on a steam heated drying cylinder.

2. *Quenching Effect of Whitewater*

The dyeings were carried out in exactly the same manne as those described above except that one set of dyeings wa carried out in tap-water, and the other set in syntheticall prepared whitewater. Both sets were sized with 2% rosi and 4% aluminium sulfate in the manner described above

The "synthetic" water for the whitewater dyeings wa prepared by sizing a large quantity of bleached sulfite pul S.R. 40°, at 2% consistency, with the addition of 2% rosi and 4% aluminium sulfate; the sized pulp was then dilute to 0.5% consistency and filtered through 200-mesh wire gauze The filtrate was used for the whitewater dyeings—200 ml. t 2.5 g. of bleached sulfite pulp.

3. *Quenching Effect of Prior Addition of Aluminium Sulfate*

In order to determine the effect of prior addition of alumin ium sulfate, a series of tests similar to those described unde (1) above was carried out on a selected number of agents. I this series the aluminium sulfate was added to the wate before addition of the whitening agent, and these pattern were compared with patterns prepared by the normal order o addition—agent, rosin, alum.

4. *Effect of Aluminium Sulfate on Unsized Papers*

In these tests, no rosin was added during the dyeing opera tion. In one set, the whitening agent was added to th pulp suspension in tap-water, and in a second set 5% alumin ium sulfate was added after the addition of the whitenin agent.

5. *Effect of Aluminium Sulfate on Dilute Solutions of Whitening Agents*

Solutions were prepared, containing aluminium sulfate 4 g.p.l., whitening agent, 0.2 g.p.l., and allowed to stand fo 30 minutes. The formation and color of the precipitat formed was noted.

6. *Measurement of Fluorescence of Patterns*

Three sheets were prepared for each test, and the fluo rescence of the patterns was assessed by measurement of tota fluorescence on the EEL Fluorescent Light Meter. Tw measurements were made on each side of each sheet, makin 12 measurements for each test. The results given are th mean of at least two such tests.

In these tests, the various agents were applied at con centrations corresponding to normal application in bulk, tha is, to produce whitenesses similar to that produced by 0.1% Fluolite C based on the dry pulp weight (1 kg. per ton pulp)

LITERATURE CITED

1. Morgan, V. G. and White, W. A. S., *Proc. Tech. Sect. Brit Paper & Board Makers*, Vol. 38, Part 1 (1957).
2. Berger, A. and Unterbirker, H., *Das Papier* (Jan.), Vol. 13 (1959).
3. Car, W., *Paper Maker & Brit. Paper Trade J.*, (Sept., Par 1; October, Part 2) 1959.

SUSTAINING MEMBERS AND ADVERTISERS

Abbé Engineering Co.
Air Reduction Chemical & Carbide Co., Inc.
Albany Felt Co.
Allied Chemical Corp.
General Chemical Div.
National Aniline Div.
Nitrogen Div. ..... 84 A
Plastics Div. ..... 72 A
Solvay Process Div. ..... 39 A
Allis-Chambers Mfg. Co. ..... 42 A
American Bitumels & Asphalt Co.
American Cyanamid Co. (Paper Chemical Dept.)
American Cyanamid Co. (Pigments Div.) ..... 64 A
American Defibrator, Inc.
American Key Products, Inc.
American Marietta Co.
American Oil Co. (Industrial Div.) ..... 87 A
American Potash & Chemical Corp.
American S. F. Products, Inc.
American Viscose Corp. ..... 35 A
Anaconda American Brass Co.
Analytical Measurements, Inc.
Anglo-American Clays Corp.
Anheuser-Busch, Inc. (Corn Products Div.)
Appleton Machine Co.
Appleton Wire Works, Inc.
Appleton Mills ..... 73 A
Arabol Mfg. Co.
Armco Steel Corp.
Arnold, Hoffman & Co., Inc.
Asten-Hill Mfg. Co.
Atlantic Refining Co. ..... 28 A
Atlas Chemical Corp. ..... 99 A

Babcock & Wilcox Co., The (Boiler Div.)
Babcock & Wilcox Co., The (Tubular Products Div.)
Bailey Meter Co. ..... 36 A
Bauer Bros. Co., The ..... 33 A
Becco Chemical Div. (Food Machy. & Chemical Corp.)
Bechtel Corp.
Bellmer Maschinen Fabrik Kg
Beloit Eastern Corp. ..... 85 A
Beloit Iron Works ..... 29 A, 30 A
Betz Laboratories, Inc. ..... 89 A
Bird Machine Co. ..... 15 A
Black-Clawson Co., The
Bolton & Son, Inc., John W. ..... 2nd Cover
Borden Co., The (Chem. Div.) (Polyco-Monomers)
Borden Co., The (Coating & Adhesives)
Bowen Corp., The
Brandon Sales, Inc.
Buckman Laboratories, Inc. ..... 4th Cover
Buckley, Dunton Pulp Co.
Bunge Pulp & Paper Co.
Burtonite Co., The

Cabble Wire Co., Inc.
Cady & Co., E. J.
Cameron Machine Co.
Carborundum Company, The
Carthage Machine Co.
Catlin Corp. of America
Celgar, Ltd.
Cellulose Sales Co., Inc.
Central Soya Co. (Chemurgy Div.)
Chain Belt Co.
Chelate Chemicals Corp.
Chemipulp Process, Inc. ..... 109 A
Cheney Bigelow Wire Works
Chicago Bridge & Iron Co.
Chromium Corp. of America
Ciba Company, Inc.
Cities Service Oil Co. ..... 79 A
Clark-Aiken Co., The
Clark & Vicario Corp.
Cleary Corp., W. A.
Clinton Corn Processing Co. ..... 80 A
Colton Chemical Co. (Div. of Air Reduction Co., Inc.)
Columbia-Southern Chemicals (refer to Pittsburgh Plate Glass Co., Chemical Div.)
Comac Engineering, Inc.
Combustion Engineering, Inc. ..... 82 A
Corn Products Co. (Industrial Div.) ..... 57 A
Corite Reynolds Corp. ..... 50 A
Crane Packing Co. ..... 26 A
Crosby Chemicals, Inc.
Cummins & Barnard, Inc. ..... 189 A
Curtiss Wright Corp.

Darling & Co.
Dexter Chemical Co. ..... 24 A
DeZurik Corp.
Diamond Alkali Co.
Dicalite Div. (Great Lakes Carbon Co.)
Dixon Chemical & Research, Inc.
Dominion Eng. Co., Ltd. ..... 91 A
Dorr-Oliver, Inc. ..... 48 A, 49 A
Dorries, A. G. O. ..... 68 A
Dow Chemical Co., The (Chem. Sales Dept.) ..... 92 A, 93 A
Dow Chemical Co., The (Coating Sales Dept.) ..... 62 A, 63 A
Dow-Corning Corp.
Draper Bros. Co.
du Pont de Nemours & Co., Inc., E. I. (Dyestuffs)
du Pont de Nemours & Co., Inc., E. I. (Electrochemicals) ..... 80 A, 81 A
du Pont de Nemours & Co., Inc., E. I. (Pigments) ..... 34 A
du Pont de Nemours & Co., Inc., E. I. (Vinyls)

Earl Paint Corp.
East Chicago Machine Tool Co.
Eaton Mfg. Co. (Dynamatic Div.) ..... 61 A
Ebasco Services, Inc.
Ehrsam & Sons Mfg. Co., J. B.
Egan & Co., Frank W.
Eimco Corp., The
Electric Controller & Mfg. Co. (Div. Sqaure D Co.)
Electric Machinery Mfg. Co.
ESCO Corp.
Elliott Co.
Endura Corp.
Epic, Inc.

Fabri-Valve Co. of America ..... 158 A
Farrell-Birmingham Co., Inc.
Felker Bros. Mfg. Co.
Ferguson Co., The H. K. ..... 189 A
Fischer & Porter, Inc.
FMC Corp. (Chlor-Alkali Div.) ..... 59 A
Foxboro Co., The ..... 16 A, 17 A
Freeport Sulphur Co.
Fuller Co., H. B.

Gardner International Corp.
Geigy Chemical Corp. ..... 20 A
General Dyestuff Co. (General Aniline & Film Corp.) ..... 69 A
General Electric Co.
General Tire & Rubber Co. (Chemical Div.)
Georgia Kaolin Co.
Gilbert Associates, Inc. ..... 189 A
Glidden Co., The (Chemicals Pigments-Metals Div.)
Goodyer Tire & Rubber Co., Inc. (Chem. Div.) ..... 11 A
Goslin-Birmingham Mfg. Co., Inc.
Gottesman & Co., Inc. ..... 10 A
Goulds Pumps, Inc. ..... 67 A
Graver Tank & Mfg. Co.
Great Lakes Carbon Corp. (Mining & Mineral Prod. Div.)
Grinnell Co., Inc.
Gurley, W. & L. E.

Hanchett Mfg. Co. ..... 108 A
Hauser-Stander Tank Co.
Heppenstall Company
Hercules Powder Co. ..... 53 A

Please mention *Tappi* when writing to Advertisers

SUSTAINING MEMBERS AND ADVERTISERS

Hermann Manufacturing Co.
Hoad & Associates, Inc., John G. ..... 189 A
Hodag Chemical Corp. ..... 56 A
Holyoke Machine Co. ..... 121 A
Hooker Chemical Corp. ..... 27 A
Hooper Corp., S. W. ..... 37 A
Houghton & Co., E. F.
Huber Corp., J. M. (Paper Div.) ..... 4 A
Hubringer Co., The
Huffman, Wolfe, Southern Co., The
Huntington Rubber Mills, Inc.
Huyck Felt Co. ..... 9 A

Improved Machinery, Inc.
Industrial Nucleonics Corp.
Infilco, Inc. ..... 60 A
Ingersoll-Rand Co. ..... 55 A
Inglis Co., Ltd., John ..... 58 A
Instron Engineering Corp.
Instrument Development Laboratories, Inc.
Inta-Roto Machine Co., Inc. ..... 65 A
Interchemical Corp.
International Nickel Co., Inc.
I-T-E Circuit Breaker Co. (Switchgear Div.)

Jacksonville Blow Pipe Co. ..... 108 A
Jagenberg-Werke A./G.
Jenssen Co., Inc., G. D. ..... 190 A
Johns-Manville Corp. (Celite)
Johns-Manville Corp. (Transite)
Johnson & Co., Inc., Alvin H. ..... 190 A
Johnson Corp., The ..... 47 A
Jones Corp., E. D.

Kalle-Regulatorer, A./B.
Kamyr, Inc.
Keever Starch Co., The ..... 54 A
Kelco Co., The ..... 86 A
Kellogg Co., The M. W.
Keratine Co., Inc., The
Kidde Constructors, Inc., Walter ..... 190 A
Kinetic Dispersion Corp.
Knox Woolen Co.
Koppers Co., Inc. (Hopper-Swift Div.)
Koppers Co., Inc. (Plastic Div.)
Krauss-Maffei-Imperial

Laing Son & Co., Ltd., James
Langston Co., Samuel M.
Lehman Co., Inc., J. M.
Levy Co., Inc., Frederic H.
Liberty Engineering Co.
Lindsay Wire Weaving Co.
Link-Belt Co.
Arthur D. Little, Inc. ..... 190 A
Litzler Co., Inc., C. A.
Lockport Felt Co.
Lockwood Greene Engineers, Inc. ..... 190 A
Lodding Engineering Corp.
Lummus Co., The ..... 190 A
Lunkenheimer Co., The

Main, Inc., Chas. T. ..... 190 A
Manchester Machine Co.
Marbon Chemical Co. (Borg Warner Corp.) ..... 43 A
Mason, Neilan Regulator Co.
Meincke & Sons, Inc., A. M.
Midland-Ross Corp.
Milton Roy Co.
Minerals & Chemicals Philipp, Inc. ..... 92 A
Minneapolis-Honeywell Regulator Co.
Mississippi Lime Co.
Mixing Equipment Co., Inc. ..... 38 A
Monsanto Chemical Co. (Plastics Div.)
Moore & White Co., The
Morden Machines Co. ..... 21 A
Morningstar Paisley, Inc.
Mount Hope Machinery Co.
Mount Vernon Mills, Inc. (Mt. Vernon Dryer Felt Co. Div.)
Murray Manufacturing Co., D. J.

Nalco Chemical Co.
Nash Engineering Co.
National Starch & Chem. Corp.
Neville Chemical Co.
New England Lime Co.
New Jersey Zinc Co. ..... 97 A
Newport News Shipbuilding and Drydock Co. ..... 3rd Cover
Neyrpic
Nichols Engineering & Research Corp.
Noble and Wood Machine Co.
Nopco Chemical Co. ..... 46 A
Norton Company

Oakite Products, Inc. ..... 25 A
O'Donoghue & Co., Roderick ..... 190 A
Ohio Blow Pipe Co. ..... 18 A
Ohmart Corp., The
Olin Mathieson Chemical Corp. (Chem. Div.) ..... 88 A
Orr Felt & Blanket Co., The ..... 51 A
Owens Corning Fiberglas Corp.

Paper & Paper Products
Paper & Pulp Testing Lab. ..... 190 A
Parsons & Whittemore/Lyddon Organization ..... 77 A
Patton Mfg. Co., Inc.
Peaboby Engineering Corp.
Peacock Business Press, Inc.
Penick & Ford, Ltd., Inc. ..... 83 A
Penobscot Chemical Fibre Co. ..... 41 A
Pennsylvania Industrial Chem. Corp.
Pennsalt Chemicals Corp.
Perkins and Sons, Inc., B. F.
Permutit Div., The (Pfaulder-Permutit, Inc.) ..... 2 A
Pfaulder Co., Div. (Pfaudler-Permutit, Inc.)
Pfeifer & Schultz ..... 190 A
Philadelphia Quartz Co.
Pittsburgh Plate Glass Co. (Chemical Div.)
Pope and Evans ..... 190 A
Portland Copper & Tank Works ..... 118 A
Prior Chemical Corp.
Pyroxylin Products, Inc. ..... 111 A

Ralston Purina Co.
Raybestos-Manhattan, Inc. ..... 44 A, 45 A, 104A
Rayonier, Inc.
Reichhold Chemicals, Inc.
Reliance Electric & Engineering Co.
Research-Cottrell, Inc.
Rice Barton Corp.
Riegel Paper Corp. ..... 71 A
Robbins Instrument Co., Inc. ..... 104 A
Rohm & Haas Co. (Resinous Products Div.) ..... 32 A, 75 A, 76 A
Roots-Connersville Blower Div. (Dresser Industries)
Rosenblad Corp.
Ross Engineering Co., J. O.
Roy Co., Milton
Rust Engineering Co.

Sandoz Chemical Co.
Sandusky Foundry & Machine Co.
Sandy Hill Iron & Brass Works

SUSTAINING MEMBERS AND ADVERTISERS

Scapa Dryers, Inc. ..... 31 A
Scott Testers, Inc.
Shawinigan Resins Corp. ..... 53 A
Shuler & Benninghofen Co. ..... 66 A
Simmonds Saw & Steel Corp.
Simmons, Worden, White Co.
Simplex Wire & Cable Co.
Sinclair Co.
Sinclair & Valentine Co.
Sirrine Co., J. E. ..... 190 A
SKF Industries, Inc.
Smidth & Co., F. L.
Smith Corp., A. O.
Socony-Mobil Oil Co.
Southern Clays, Inc.
Southworth Machine Co.
Sprout, Waldron & Co., Inc. ..... 70 A
Square D Co. (E. C. & M. Div.) ..... 23 A
S & S Corrugated Machinery Co. ..... 1 A
Staley Mfg. Co., A. E.
Stebbins Engineering & Mfg. Co.
Stein, Hall & Co., Inc.
Stevens, Inc., Charles R.
Stickle Steam Specialties Co. ..... 153 A
St. Lawrence Starch Co.
Stone & Webster Engineering Corp.
Stowe-Woodward, Inc.
Sun Chemical Corp.
Sunday & Associates, George M.
Swenson Evaporator Co.

Taylor Instruments Cos. ..... 30 A, 31 A
Tennessee Corp. ..... 107 A
Testing Machines, Inc.
Texas Gulf Sulfur Co. ..... 3 A
Thiele Kaolin Co.
Thwing-Albert Instruments Co. ..... 172 A
Tidewater Construction Corp.
Tidland Machine Co.
Titanium Pigment Corp. ..... 8 A
Tracerlab, Inc.
Tragacanth Importing Corp. (TIC)
Traylor Eng. Mfg. Div. (Fuller Co.)
Trimbey Machines, Inc.
Tyler Co., W. S.

Union Screen Plate Co. of Canada
Union Starch & Refining Co.
United Eng. & F'dry Co. ..... 40 A
United State Movidyn Corp.
U. S. Industrial Chemicals Co. (Div. Natl. Distillers & Chem. Corp.)
U. S. Rubber Co. (Naugatuck Chem. Div.) ..... 19 A

Valley Iron Works Corp. ..... 74 A
Valmet OY
Vanderbilt Co., Inc., R. T. ..... 13 A
Vermont Kaolin Corp.
Vineland Chemical Co.
Virginia Chemicals & Smelting Co. (Industrial Div.)

Waldron-Hartig Div. (Midland-Ross Corp.) ..... 94 A
Wallace & Tiernan, Incorporated ..... 158 A
Wallerstein Co. (Baxter Lab., Inc.) ..... 52 A
Warren Pumps, Inc.
Waterbury & Sons Co., H. ..... 101 A
West End Chemical Co. (Div. Stauffer Chem. Co.) ..... 78 A
Western Precipitation Div. (Joy Mfg. Co.)
Westinghouse Electric Co.
Weyerhaeuser Co.
Whittaker, Clark & Daniels, Inc.
Wica Chemicals, Inc.
Wilco Machine Works, Inc.
Wisconsin Wire Works
Wyandotte Chemical Corp. (Michigan Alkali Div.) ..... 123 A, 125 A, 127 A

Youngstown Miller Corp.

Zeiss, Inc., Carl

Please mention *Tappi* when writing to Advertisers

GUIDE TO PROFESSIONAL SERVICES

CUMMINS & BARNARD, INC.
Financial Comparisons and Analyses
Steam, Electric, and Process Systems
Plans, Specifications, and Construction Management
2058 South State Street, Ann Arbor, Michigan
Pensacola, Florida — Whittier, California
Engineers Serving the Industry since 1932

GILBERT ASSOCIATES, INC.
Engineers and Consultants
• Generation, Distribution and Application of Steam and Electric Power • Waste Treatment • Water and Sanitary Facilities • Studies and Reports • Plans and Specifications • Supervision of Construction
New York, N. Y. — **Reading, Pa.** — Washington, D. C.

THE H. K. FERGUSON COMPANY
A Subsidiary of Morrison-Knudson Company, Inc.
INDUSTRIAL ENGINEERS & BUILDERS
PULP & PAPER DIVISION
Study—Design—Construction—Start-up
Main Office: Cleveland, Ohio
Other Offices: New York • San Francisco • London • Paris • Sao Paulo

Complete professional engineering services
for the pulp and paper industry
JOHN G. HOAD & ASSOCIATES, INC.
Consulting Engineers
YPSILANTI, MICHIGAN

GUIDE TO PROFESSIONAL SERVICES

G. D. JENSSEN CO., INC.
49½ Maple St., P.O. Box 366, Massena, N. Y.
SULPHITE MILL ACID PLANTS—SEMICHEMICAL LIQUOR PLANTS
Sulfur Burning Plants • Jenssen Two Tower Acid Systems • Gas Coolers—Surface and Spray Type • Jenssen Pressure Acid Systems • Jenssen Auxiliary Process Towers • Recovery Plants—Cooking Acid
SOLUBLE BASE ACID PLANTS •
JENSSEN SO_3 ABSORPTION SYSTEMS
Sulfurous Acid Preparation for Bleach Plant Application
West Coast Representative—JAMES BRINKLEY COMPANY
417—9th Avenue South—Seattle, Washington

CHAS. T. MAIN, INC.
ENGINEERS
Process Studies, Design, Specifications and Construction Supervision
PULP AND PAPER MILLS
Steam Hydraulic and Electrical Engineering
Reports, Consultation and Valuations
80 Federal Street, Boston 10, Mass.
129 West Trade Street, Charlotte, N. C.

ALVIN H. JOHNSON & CO., INC.
415 LEXINGTON AVENUE NEW YORK 17, N. Y.
CONSULTING AND DESIGNING ENGINEERS
Serving the Pulp & Paper Industries Since 1929
Telephone MUrray Hill 7-8764

RODERICK O'DONOGHUE & COMPANY
CONSULTING ENGINEERS TO THE PULP AND PAPER INDUSTRY
IMPROVED PROCESSES—DESIGNS—REPORTS
420 Lexington Ave. New York 17, N. Y.

WALTER KIDDE CONSTRUCTORS, INC.
WALTER KIDDE ENGINEERS SOUTHWEST, INC.
World Wide Services to the Pulp and Paper Industry
STUDIES, REPORTS, PLANNING, SITE SELECTION, DESIGN, ENGINEERING, PROCUREMENT, EXPEDITING, INSPECTION, CONSTRUCTION
PACKAGE CONTRACTS
NEW YORK • CHICAGO • HOUSTON • BATON ROUGE

Infrared Spectroscopy
Gas Chromatography
Certified Pulp Testers
PAPER AND PULP TESTING LABORATORIES
118 East 28 Street
New York 16, N. Y.
Trace analysis—identification of organic mixtures

ARTHUR D. LITTLE, INC.
Science • Management • Engineering
Consultants Since 1886
Main Offices and Laboratories: Acorn Park, Cambridge, Mass.
Also: New York, Washington, Chicago, San Francisco, Santa Monica, San Juan, Toronto, London, Zurich, Edinburgh, Mexico City

PFEIFER & SHULTZ...Engineers
Steam Power Plant Specialists
- Mills and Industrial Buildings
- Reports
- Plans and Specifications
- Supervision of Construction

Wesley Temple Bldg., Minneapolis 3, Minn.

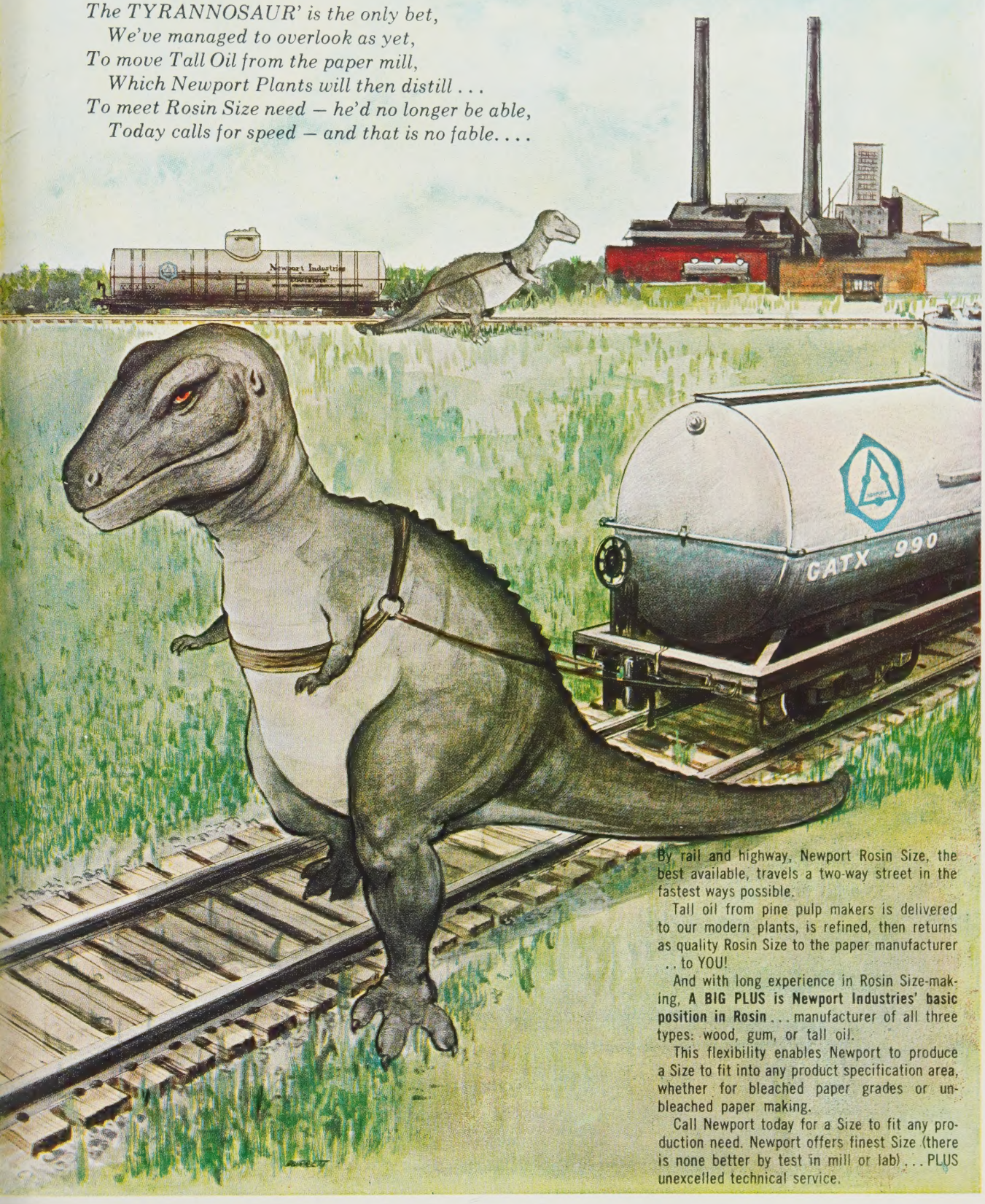
LOCKWOOD GREENE ENGINEERS, INC.
Est. 1832
Plant Location • Site Studies • Paper • Pulp Mills • Mill Expansion • Water • Waste • Steam-Electric Power and Utilization • Reports • Appraisals
New York 17, N. Y., 41 East 42nd Street
Spartanburg, S. C., Montgomery Bldg.
Boston 16, Mass., 316 Stuart Street

POPE and EVANS
Consulting Engineers
Surveys Reports Design
relating to the
Generation, Distribution and Utilization
of
Steam and Electric Power
Main Office: 21 East 40th Street, New York 16, N. Y.

THE LUMMUS COMPANY
for over half a century
Engineers and Constructors
for Industry
PULP AND PAPER MILL DIVISION
design, construction, reports, consultation
385 Madison Ave., New York 17, N. Y.
Newark, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid

J. E. SIRRINE CO. Engineers
Greenville, S. C.
Est. 1902
Paper • Pulp Mills • Waste Disposal • Textile Mills • Appraisals • Water Plans • Steam Utilization • Steam Power Plant • Hydro-Electric • Reports

The TYRANNOSAUR' is the only bet,
We've managed to overlook as yet,
To move Tall Oil from the paper mill,
Which Newport Plants will then distill . . .
To meet Rosin Size need — he'd no longer be able,
Today calls for speed — and that is no fable. . . .



By rail and highway, Newport Rosin Size, the best available, travels a two-way street in the fastest ways possible.

Tall oil from pine pulp makers is delivered to our modern plants, is refined, then returns as quality Rosin Size to the paper manufacturer . . to YOU!

And with long experience in Rosin Size-making, **A BIG PLUS is Newport Industries' basic position in Rosin** . . . manufacturer of all three types: wood, gum, or tall oil.

This flexibility enables Newport to produce a Size to fit into any product specification area, whether for bleached paper grades or unbleached paper making.

Call Newport today for a Size to fit any production need. Newport offers finest Size (there is none better by test in mill or lab) . . . PLUS unexcelled technical service.

NEWPORT NAVAL STORES CHEMICALS
INDUSTRIES DIVISION
P. O. DRAWER 911, PENSACOLA, FLORIDA

HEYDEN NEWPORT CHEMICAL CORPORATION

TRADEMARKS REGISTERED
U. S. Pat. Off. and in Other Countries

Serving the Paper Industry Throughout the World

BUCKMAN
LABORATORIES, INC.
MEMPHIS 8, TENNESSEE, U.S.A.
CABLE ADDRESS BULAB

INDUSTRIAL
MICROORGANISM
CONTROL
SPECIALISTS